The Foundry Trade Journal
AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 17. FEBRUARY, 1915. No. 158.

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.
To place the "Journal" within the reach of Working Moulders and Pattern-makers, the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.
All communications to be addressed to the Editor, or to the Publisher, as the case may be, of
The Foundry Trade Journal,
165, Strand, London, W.C.

WE INVITE PRACTICAL ARTICLES ON THE TRADE IN ALL ITS BRANCHES, WHICH WILL BE PAID FOR. MSS. SHOULD BE WRITTEN ON ONE SIDE OF THE PAPER ONLY.

THE NEW YORK PUBLIC LIBRARY
745558 A
ASTOR, LENOX AND TILDEN FOUNDATIONS
R 1934 L

BRITISH FOUNDRYMEN'S ASSOCIATION.
LIST OF SECRETARIES—

General Secretary: E. A. Pilkington, Brook House, Sheepbridge, Chesterfield.
Manchester: A. Harrison, 705, Manchester Road, Castleton.
Birmingham: C. Grindlay, 39, Copeley Hill, Erdington, Birmingham.
Sheffield and District: R. W. Kemlo, 6, Lees Hall Road, Meersbrook, Sheffield.
Scottish: W. C. Gray, Royal Technical College, Glasgow.
London: Alexander Hayes, 165, Strand, London, W.C.
Halifax: J. G. Robinson, 17, Gibraltar Road, Halifax.
Newcastle-on-Tyne: H. A. J. Rang, Cleveland Road, North Shields.
Leicester and District: S. H. Russell, Bath Lane, Leicester.

Contents

	PAGE
Notes and Comments	69
Works of Steel Castings, Limited	71
Melting Nickel Bronze at the Royal Mint	73
Modern Locomotive Piston-Valve Cylinders	74
Machinery for the Treatment and Mixing of Sands and Moulding Materials	79
Bauxite for Refractory Goods	80
Eighteenth Century Metal Work	81
Studies on Cast Iron	82
The Nickel Industry	83
Malleable Iron Castings	84
British Foundrymen's Association	86
Foundry Management: Commercial	87
Making a Cone Pulley in Skin-Dried Green Sand	91
The Foundry Chemist	92
Melting Processes and Furnace Construction for Malleable Cast Iron	94
"F.T.J." Bookshelf	98
Trade Talk	99
Inventions	102
Deaths	102
Personal	104
New Companies	104
Monthly Price Lists	106

Forthcoming Events.

FEBRUARY 13.
British Foundrymen's Association (Scottish Branch).—"The Moulding of Turbine Casing in Loam," by Wm. Bell, Jnr.

FEBRUARY 23.
British Foundrymen's Association (Sheffield Branch).—"Copper-Aluminium Alloys and Their Properties," by Prof. C. A. Edwards, D.Sc.

FEBRUARY 26.
British Foundrymen's Association (London Branch).—Discussions on Foundry Problems.

FEBRUARY 27.
British Foundrymen's Association (Newcastle-on-Tyne Branch).—Open discussion.
British Foundrymen's Association (Birmingham Branch).—"The Use of Producer Gas in a Foundry," by T. McFarlane.

MARCH 6.
British Foundrymen's Association (Halifax Branch).—"Copper Alloys, with Notes on Brass Founding," by H. L. Reason.
British Foundrymen's Association (Lancashire Branch).—"Copper-Aluminium Alloys," by Prof. C. A. Edwards, D.Sc.

NOTES AND COMMENTS.

Design of Malleable-Iron Castings.

There is little doubt that the adoption of malleable-iron castings for many engineering purposes has in the past been retarded by lack of knowledge of the principles of design. The consideration of first importance in designing for malleable-iron castings is to avoid those forms and shapes which accentuate the troubles caused by shrinkage. Sudden changes in the weight of the section should be carefully avoided, since the larger section will invariably show shrinkage cavities, due to the metal being drawn to feed the shrinkage of the smaller part. Where thick and thin parts in juxtaposition cannot be avoided, the difference should be made as little as permissible, and the heavier part, if possible, should be fed during its own cooling to compensate for the depletion of metal by the thin part.

Although it is commonly believed that malleable cast iron is only suitable for light sections, this belief is erroneous and is probably the result of attempting to make heavy castings from a mixture suitable for light work. There is quite a wide range within which malleable-iron castings may be made satisfactorily, provided a composition suitable for the section is employed. A mixture which would give a perfectly white casting when cooled at the rate normal for thin work might readily give a grey-spotted or mottled casting when in a thick section, owing to prolonged rate of cooling, such a casting being, of course, unsuitable for malleableising. A fact sometimes overlooked is that a perfectly white iron cast in large bulk may be found to have a small grey centre, owing to the protracted retention of heat allowing some of the carbon to separate out as graphite.

If, however, a satisfactory white-iron casting is made, it is chiefly a question of the period of annealing as to whether it can be malleableised. There is, of course, the difficulty that the low-silicon low-carbon mixture which will give a thick white casting is essentially a less fluid metal and thus more difficult to pour; but thick castings, in any case, do not require such fluid metal as do thin ones. It must be admitted that in ore-annealing practice with thick work the results are not so satisfactory as in black-heart practice, owing to the excessive decarburisation of the skin, due to the long period of contact with the ore which is necessary to affect the change throughout the metal. Less difficulty is experienced when the sulphur is low (lower than is frequently the case with Reaumur work), as the breaking down may then be affected mainly by heat, whereas the oxidising influence of the ore in addition to heat is essential with high sulphur. The low-sulphur American product, accordingly, is more suitable for heavy work than is the high-sulphur Reaumur or European metal.

As regards section in relation to annealing, in Reaumur practice, with its decarburising anneal-

ing, satisfactory results are not obtained with castings that vary much in thickness, for when the thickest parts are thoroughly annealed the thinner sections have long since passed their best and toughest condition. This feature is not of such importance with black-heart material unless packed in an oxidising packing, for the process does not greatly involve decarburisation and accordingly the extended time requisite to precipitate the carbon in the thick sections does not deplete the thin sections as in ore annealing. Since oxidising packings are used in black-heart practice also, however, in such case great variations of section are to be avoided, though the shorter annealing period necessary for only precipitating the carbon allows greater play.

A further feature to be borne in mind both by designer and patternmaker, is the expansion which occurs during annealing. While white iron, as is well known, contracts about ¼ in. to the foot in solidifying and cooling, the annealing process causes an increase in volume, often reducing the initial contraction by half in the case of black-heart material. This is caused by the conversion of the combined carbon into temper or annealing carbon, the effect being similar to that produced by the separation of graphite on the solidification of grey iron. The possibility of this annealing expansion, however, must be considered in the light of the process used, the carbon content of the iron (whether high or low), and the time of annealing and consequent decarburisation, as the expansion may be negligible or absent in Reaumur metal which is well decarburised during annealing.

Sulphur and its Removal.

In the course of an address before the Philadelphia Foundrymen's Association, recently, Mr. W. F. Prince discussed the subject of sulphur segregations, and the possibilities of a process for the reduction of sulphur in foundry irons. He continued :—"One day a piece of iron which showed a lot of kish was brought to me, and analysis showed it to be high in sulphur. A hole drilled in the clean iron just under the bad spot disclosed that part to be low in sulphur—only 0.02. I believed the boiling of the mould collected the sulphur and drew it up to the bad spot; so I took a ladle and put a hole in the bottom, connected it with an air hose, turned on the air and then tapped the iron into the ladle. The iron was boiled for about ten minutes, and on the top of the ladle was found a lot of kish, and analysis of the metal showed that the process had taken out about 35 per cent. of the sulphur. I have made hundreds of tests and I find I can at will take out from 25 to 50 per cent. of the sulphur. The oxygen in contact with the manganese creates an oxide and this rises, the affinity between it and the sulphur being so great that it draws the sulphur and drags it to the top, where it may be skimmed off. Sulphur causes troubles that I did not know of until I became interested in this process. A large condenser was cast and the top flange showed the familiar kish and shrinkage. On analysing the top flange, I found it to contain sulphur 0.196, and the bottom flange, sulphur 0.084. Dropping the iron from the top had caused agitation and the action which brought the sulphur to the top. Spongy castings and hard castings from seemingly soft mixtures are caused by this agitation that robs the sulphur from one spot and delivers it to another."

The foregoing experiment is interesting, but, accepting Mr. Prince's deductions as correct, it obviously is limited to certain classes of iron—those fairly high in both silicon and manganese. As is well known, the blowing of metal in the Bessemer converter first attacks the silicon, the oxidising of the manganese being most prominent about the middle of the blow. Given a high silicon content, however, it is feasible that the inevitable oxidation of silicon in the process under discussion would give an increase of temperature which, accompanied by the ebullition of the metal, would allow the affinity of manganese for sulphur to form manganese sulphide which would rise as slag and somewhat eliminate the sulphur. A loss of both silicon and manganese also, however, would appear inevitable, and with low-manganese irons it is highly probable that the oxidation of the metal would cause more harm and trouble than the high sulphur. Apart from this, the process certainly is worthy of attention and a little independent experiment to see how far it is applicable to various irons.

British Foundrymen's Conference in 1915.

The question of whether or not the usual Annual Conference of the British Foundrymen's Association (projected next for Leeds) should be held this year, in view of the disturbed conditions created by the war, was recently discussed by the Council. Following that a special meeting was called in Leeds on January 20 to consider the matter, and it was reported finally that, "Great satisfaction was felt at the idea of holding the Conference in Leeds, and under normal conditions it was considered that it would be thoroughly successful. But under the present conditions it was deemed advisable to postpone the Conference until next year." This decision can cause little surprise amongst the members, and the course adopted will doubtless be followed by most technical institutions this year. An essential feature of interest in the Annual Conference consists of the visits to important works; but with so many important works engaged on Government work and operating under pressure, such visits would be out of the question. It would be difficult at the present, too, to imbue the social functions of the Conference with just the desired spirit of heartiness, when so many familiar figures would be absent at the call of the country's military or industrial duties. The annual business meeting of the Association will be held in London on a date to be announced later.

Restriction of Capital Issues.

Now that the Stock Exchange has re-opened, the Treasury has been considering the question of new capital issues during the continuance of the war. The authorities are of opinion that during the crisis all other considerations must be subordinated to the paramount necessity of husbanding the financial resources of the country with a view to the successful prosecution of the war. Accordingly all fresh issues of capital must be approved by the Treasury before they are made. Treasury approval will be governed by the following general conditions :—

(1) Issues for undertakings carried on or to be carried on in the United Kingdom shall only be allowed where it is shown to the satisfaction of the Treasury that they are advisable in the national interest.

(2) Issues or participations in issues for undertakings carried on or to be carried on in the British Empire overseas shall only be allowed where it is shown to the satisfaction of the Treasury that urgent necessity and special circumstances exist.

(3) Issues or participations in issues for undertakings carried on or to be carried on outside the British Empire shall not be allowed.

(4) The Treasury will not in ordinary cases insist upon the above restrictions where issues are required for the renewal of Treasury bills or other short instruments held here and falling due of foreign or Colonial Governments or municipal corporations or railways or other undertakings.

Works of Steel Castings, Limited.

Steel Castings, Limited, was registered in January of last year, with Mr. Henry Archibald (late of Messrs. William Beardmore & Company, Limited) as managing director, and offices at 113, St. Vincent Street, Glasgow. The Company were fortunate enough to acquire the Carntyne Foundry at Parkhead, which was formerly in the occupation of Messrs. Campbell, Binnie, Reid & Company, but which, at the time it was taken over, had been void for some four years. The works are extensive and well built, though of course repairs were required and many structural alterations necessary to fit them for the present undertaking, for which their position renders them particularly favourable, being within easy reach of Glasgow and close to Parkhead Station on the North British Railway, sidings from whose lines run direct into the works.

Fig. 1.—Main Foundry; Steel Castings, Limited.

As at present laid down, the works are designed for the production of steel castings up to 10 tons in weight for the general engineering trades, steel ingots, moulded gears and special ingots and castings in nickel steel, vanadium steel, chrome steel, manganese and silicon steels.

The offices front, and the works have a gateway entrance, on to the Old Edinburgh Road. The pattern shop, which is immediately at the entrance of the works, is 120 ft. by 40 ft. by 23 ft. high. Above this is the pattern loft, whilst tandem with it a lean-to building has been erected for the storage of foreign patterns. At the opposite end is the sand-mixing shop, which has the usual equipment of sand-sifters and runner mills.

The main foundry building, which lies at the other end of the yard, is 200 ft. by 40 ft. by 34 ft. high to the eaves, with an annex, where the lighter castings are made, 70 ft. by 35 ft. by 20 ft. It is in this direction that the Company propose to make considerable extensions to the foundry floor. The main bay is served by two 20-ton Royce electric cranes and three wall cranes. Obviously hand moulding is almost exclusively adopted. The Stewart wheel-moulding machine, however, is worthy of special mention. Upon this machine wheels can be moulded from 1 ft. up to 16 ft. in diameter and of any breadth up to 42 in. The construction of the machine is clearly shown in our illustration (Fig. 3). The machine has a cast-iron baseplate, the column being supported in a taper hole in its centre, where a feather is provided to prevent it turning in the socket. The column is made in two parts, the upper of which is turned all over and fits into a tapered socket in the lower portion, where it is secured by a cutter which passes through both. A strike arm which is carried on the column is adjustable as regards height by means of two split collars held in position by locking screws. The cast-iron dividing drum is made as light as possible and balanced. It is 4 ft. 11 in. in diameter and 18 in. wide, its surface being divided into 50 rows of holes, the first of which contains 51 and the last 100 holes. The drum is held on the column by clamping screws. The carriage is provided with a square plunger which has a vertical movement of 18 in. controlled by means of a hand-wheel, rack and pinion. The plunger may be locked in any position, whilst its guides are adjustable for wear. The jib or cross-arm is provided with screws on both sides, geared together and operated by a common hand-wheel to give radial movement to the carriage. The cross-arms are connected together at the column by a cast-iron spider revolving on a ball bearing, the vertical position of which can be altered; the position of the ball bearing is secured by a locking pin. Mounted on the jib is a bridge-piece which carries the dividing pin. This pin is

tapered, and as it is held in position in the dividing hole by a spring there is thus no slack. When the pin is withdrawn a quarter turn locks it in the "out" position. The pin can of course be moved in its vertical position, and fixed anywhere throughout

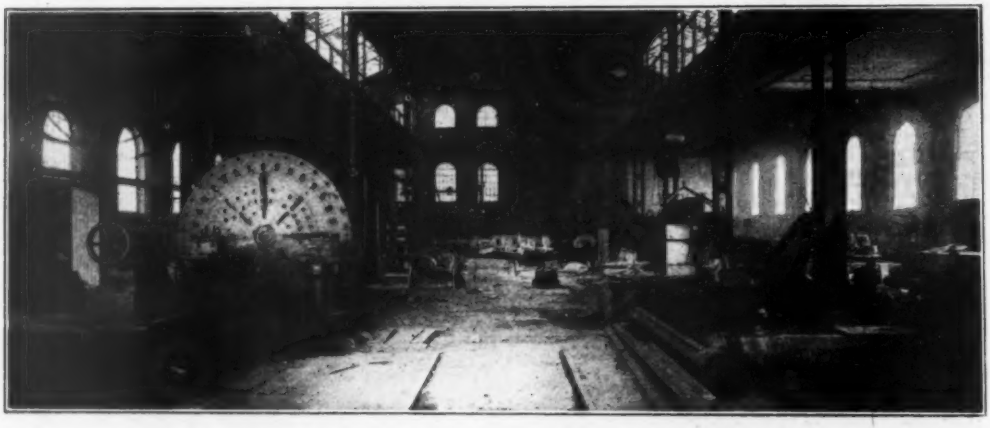


FIG. 2.—MACHINE SHOP; STEEL CASTINGS, LIMITED.

the width of the drum. The jib and carriage are balanced by a cast-iron weight.

The furnace, which is of the Siemens open-hearth latest type, with exceptionally deep chambers, has a melting capacity of 10 tons, and is served by a steel stack 65 ft. high from furnace level by 4 ft. in diameter. The tapping side of the furnace is built

FIG. 4.—HORIZONTAL FLUSH-SIDE COLD SAWING MACHINE; STEEL CASTINGS, LIMITED.

into the foundry wall, the furnace and the charging platform being covered by a lean-to. When the old cupolas have been dismantled this lean-to and the melting bench will be extended and a second similar

furnace will be put down. The old foundry ovens have been modified and adapted to gas firing. Two of these are each 20 ft. by 12 ft., and one 25 ft. by 15 ft. They are furnished with brick-lined carriages travelling on rails. The gas admission is controlled from the outside by mushroom valves, an auxiliary control for regulating the supply of gas to different parts of the ovens being obtained by slides which work over the gas-admission slots. To facilitate burning out at the week-end, all the oven flues are connected to a damper-controlled central flue which is taken to the chimney 75 ft. by 5 ft. dia.

Gas for the furnace and ovens is supplied by two Smith-Wincott water-sealed producers, the steam necessary for which is raised in a small Cochrane boiler. The yard, the ore bunkers, the producers

and the furnace charging platforms are served by a 4-ton electric jib crane.

Power for this side of the works is supplied by a 35-h.p. Crossley gas engine and a 45-h.p. Stockport gas engine, which drive through belts Mavor & Coulson machines. The machine and dressing shop is tandem to the foundry and connected therewith by a standard track, served by trolleys running on ball bearings. A Tilghman's sand-blast apparatus will occupy a space between the foundry and the machine shop.

The machine shop is 140 ft. long by 70 ft. 6 in. by 26 ft. 6 in. high, with side galleries. The machines include a large horizontal boring mill by Laing, heavy gap lathes, planing, milling, drilling machines, etc., a noticeable feature of the equipment being a powerful horizontal flush-side cold-sawing machine with its attendant saw-sharpening machine, supplied by Messrs. Clifton & Baird, Limited, Johnstone. The saw, which is direct belt-driven from the line shaft,

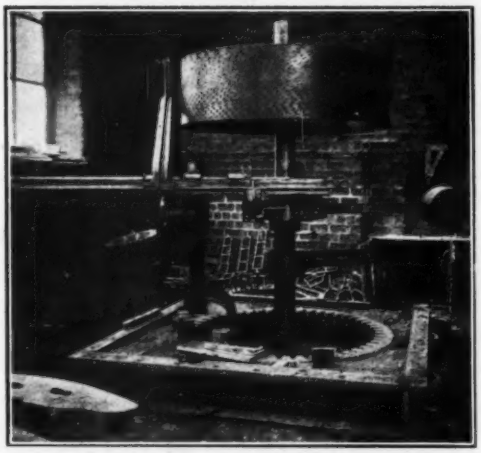


FIG. 3.—STEWART WHEEL-MOULDING MACHINE; STEEL CASTINGS, LIMITED.

is capable of cutting risers up to 9 in. in thickness and is arranged with four feeds by means of step cones and belt. Automatic stops are provided to prevent the saw overrunning in either direction. A hand-wheel is provided by means of which the saw is rapidly withdrawn (by power-operated gear) from the work when the cut is completed. The saw spindle is carried upon a heavy saddle which is mounted upon the base. The spindle is driven by a steel worm sliding on the driving shaft, to which the power is transmitted through a phosphor-bronze worm wheel. The bed of the machine forms an oil trough from which the driving worm, driving shaft, and feed screw are automatically lubricated. The table is carried on a base-plate attached to the main bed of the machine, and can be moved in or out to suit requirements, whilst the front of the base-plate next to the machine is detachable, so that a pit can be formed underneath to enable large castings to be put in position when sawing the risers.

In the saw-sharpening machine the emery wheel has a to-and-fro motion across the teeth, which are sharpened perfectly square in the form of a milling cutter. The saw is automatically turned on its axis by means of a pawl operated by levers and a cam shaft. Small hand screws are provided for adjusting the main lever to give a stroke to suit pitches of teeth from a ¼ in. to 1¼ in., and the machine will take saws from 12 in. to 42 in. in diameter.

There is also an installation of oxy-acetylene cutting plant by the British Oxygen Company, whilst an electric welding plant has recently been installed. This portion of the works is at present driven by a vertical steam engine, but it will be converted to electric drive so soon as the erection of a sub-station has been completed, current being taken from the Corporation.

Two coal-fired annealing furnaces are installed in an annex to the machine shop. The smaller of the two is of somewhat unusual design, the fire and chamber being in one; this is for the most part used for straightening, but it can be very effectively used for annealing, the work being buried in sand in which it is also allowed to cool.

Beyond this shop is the smithy, of three hearths, served by Keith-Blackman blowers.

Melting Nickel-Bronze at the Royal Mint.

The recently issued annual report of the Deputy Master and Comptroller of the Royal Mint for the year 1913 contains a Memorandum by Mr. Edward Rigg (the Superintendent of the Operative Department), including data regarding the melting of nickel-bronze bars by gas, practically 124 tons of which were required. In the course of his remarks, Mr. Rigg says:—This is the first occasion on which nickel-bronze bars have been called for since coal-gas was adopted as the sole fuel on January 24, 1911. Although the gross out-turn was 1,957.9 tons in 1913 and only 1,197.7 tons in 1909, the records are comparable owing to the fact that the proportion of bronze and nickel-bronze to the total was approximately identical—namely, 56.3 per cent. in the earlier and 55 per cent. in the later year. Taking the several items of cost, grouped under the three headings—fuel, crucibles, and wages—the results are as shown below:—

Year.	W'ght. of good bars cast.	Annual charge.				Rate per ton in shillings.			
		Fuel.	Crucibles.	Wages.	Total.	Fuel.	Crucibles	W'ge.	Total.
	Tons.	£	£	£	£	s.	s.	s.	s.
1909 ..	1197.7	1455.0	2521.1	938.8	4914.9	24.29	42.09	15.68	82.06
1913 ..	1957.9	2162.3	2613.4	1060.8	5836.5	22.09	26.69	10.84	59.62

The gross saving per ton of good bars is no less than 22.44s., or 27.3 per cent. of the total charge in 1909, and the output per furnace per day has risen as follows, the increases for the several metals dealt with being separately recorded:—

Metal.	Average melt per furnace per day.		Increase per furnace.	
	1909.	1913	Cwt.	Per cent.
	Cwt.	Cwt.		
Gold	5.2	9.8	4.6	88.5
Silver (shilling bars)	5.7	12.8	7.1	124.5
Bronze	5.2	13.4	8.2	157.7
Nickel-bronze	3.6	9.4	5.8	161.1

The increased efficiency per man employed in the melting branch on the gross output is represented by a rise from 59.6 to 73.3 tons per annum, or 23 per cent.

Modern Locomotive Piston-Valve Cylinders

By "Woodsand."

The successful and economical production of these cylinders presents far greater difficulties to the pattern-maker, moulder, and core-maker than those of the ordinary slide-valve type. With modern locomotive practice of high boiler pressure and superheated steam it is imperative that the casting shall possess the maximum strength and soundness combined with perfect freedom from blowholes, slag, etc. Most ironfounders know often by experience how small an oversight or defect in making or casting a cylinder will, at the best, lead to much expense in plugging and patching and very often to its complete rejection. Careful attention to detail is the key to success. The details of the foundry operations are well within the grasp and comprehension of the average moulder. The advantages claimed for the methods advocated in this article include considerable economy in pattern-shop and foundry, great ease and facility in making, handling and fixing cores, and given good and careful workmanship, an uninterrupted sequence of sound, clean castings, blowholes and other defects being a comparative rarity and "wasters" an unknown quantity.

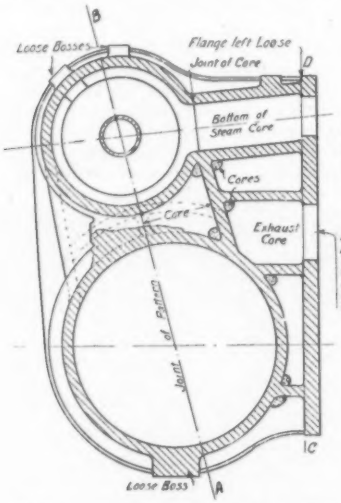


FIG. 1.—SECTION ON *a—b* OF FIG. 2.

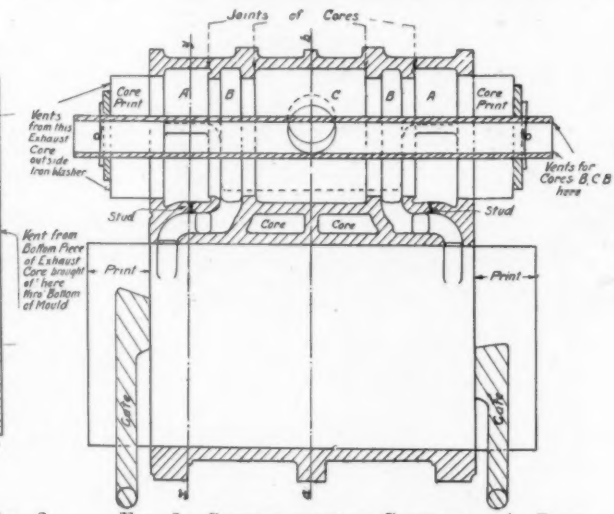


FIG. 2.—SECTION THROUGH CASTING ON *A—B* OF FIG. 1.

As seen in Figs. 1, 2 and 3, the example taken is a single outside cylinder of 20-in. bore by 26-in. stroke with piston valve 10 in. diameter, the dressed casting weighing about 26 cwts.

Patterns and Core-Boxes.

In this case only one pattern is required, as the cylinder suits either right or left hand. The pattern is jointed on line A B through the centre of barrel and valve box, the frame flange being left loose at C D (see Fig. 1). Practically all washers, brackets, lubricating and drain-cock bosses have to be skewered to the pattern and moulded loose. Ten core-boxes are required, comprising four for lightening cores, three for the exhaust, which is jointed as shown in Fig. 3, two for the steam inlet, jointed as shown in Fig. 1, and one for the passage cores.

The pattern and core-boxes are all of simple construction if made as here shown, and one pattern-maker can make pattern and core-boxes in about six weeks ordinary time.

Moulding Box.

The moulding box is constructed in four pieces, consisting of two ordinary flat barred covering boxes, 5 in. deep, with necessary snugs and swivels cast on, and two middle parts built up of "open-sand" plates bolted together with suitable holes for fastening in loose bars, clearing barrel cores, vent outlets, etc. Wrought-iron bows of ample strength are cast in for lifting and turning over. This method of making the main parts of the box is far preferable to casting each all in one piece, as these soon break at the corners or weak parts under the severe stresses involved in drying and casting. The 2-in. by 1-in. flange cast round the sides for bolting together and pins, adds considerably to their strength. Cast-iron "open-sand" bars shaped to the top half of the pattern are fastened in the main part of the cope. Fig. 8 shows a view of the complete box. The flanges round the joints of the boxes are kept back from the edges about ¼ in.; this leaves when together about ½ in. space for stopping in before casting.

Core-Irons.

All core-irons are made of cast iron. The patterns for these are fastened on flat boards. They are of the grid type, suitably prodded and all cast open-sand except the passage-core irons. These are moulded off a cast-iron pattern and have to be covered. Cast-iron core-irons are superior to

wrought-iron, both in cost of making and material and also in rigidity and convenience in dressing, as they can be broken out quite easily.

Cores.

Most of the cores are comparatively simple and easy to make and fix. It is with the cores that make up the valve box and steam passages that the greatest difficulties are encountered, both as to making and fixing, and also in regard to carrying away the vents without having recourse to superfluous holes in the casting which would afterward have to be plugged. Great accuracy in setting, absolute rigidity when fixed and ample provision for the escape of the gases generated are the essentials to be observed when making and fixing these cores in the mould. A method much advocated recently is to make the valve box and passage cores in one piece, first making in halves and then joining when dried. This method is costly in pattern-shop and foundry, the core is difficult to make and handle, and any damaged or defective part necessarily affects the whole.

The methods advocated here are superior in every way to those in general use. Five separate cores are necessary, comprising the two top sections of exhaust core A A in Fig. 2, two passage cores B B, Fig. 2, and top piece of the steam inlet C Fig. 2, to form the complete valve box. Each core has a 4-in. round hole right through it, central with the bore of the valve. The reason for this will be explained in dealing with coring up. The cores are made of loam sand, which gives a strong and porous core. They are well vented, all vents in each converging to one outlet in the centre of the 4-in. diameter hole in each. Fig. 5 shows plainly the method of venting the passage cores, wax vent being used in this case. All cores should be well blacked with good blacking and must be thoroughly dried.

Moulding.

The board is set at an angle sufficient to throw the top of the flask level when placed on it. The bottom half of the pattern is fixed in position and rammed in the usual way. Strong cast-iron frames of the required shape to support the overhanging portions of the mould (see Fig. 4) are wedged in the flask, loose pieces of ½-in. round iron being inserted as stiffeners. Great attention is paid to venting. From the known fact that for each deg. C. rise in temperature all gases under constant pressure increase in volume by $\frac{1}{273}$ of their original bulk, it will be seen that at the temperature of molten iron, say, 1,350 deg. C., any gas generated in the mould will occupy space nearly five times as great as at ordinary temperatures under the same pressure. Minute quantities of gas bubbling up through the setting iron in the mould may therefore cause comparatively large blowholes. Hence the importance of making ample provision in vents for the escape of any gas as quickly as it is generated. Parts requiring special venting should be pricked over with a sharp ⅛-in. round vent wire until they are as porous as a sponge. A layer of ashes about 1 in. thick should then be laid over the top of the vent holes and connected with holes in the box sides left for the purpose.

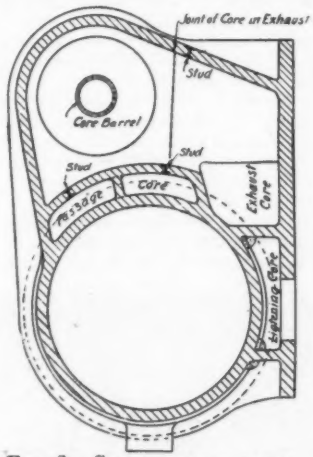


FIG. 3.—SECTION ON *x*—*y* OF FIG. 2.

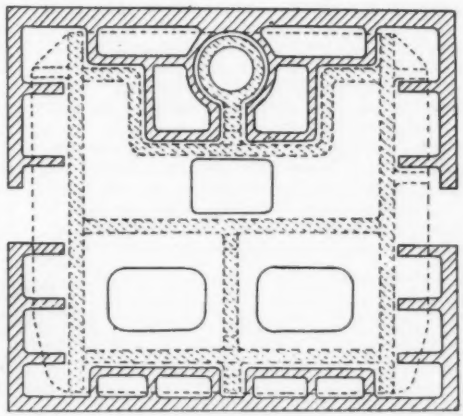


FIG. 4.—SHOWING CAST-IRON FRAMES TO CARRY OVERHANGING PARTS OF MOULD.

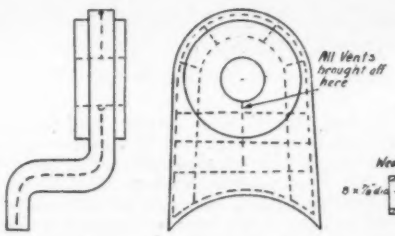


FIG. 5.—PASSAGE CORE *B*, FIG. 2.

FIG. 7.—STOPPER FOR GATES.

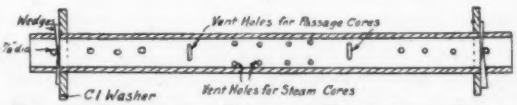


FIG. 6.—BARREL FOR CARRYING VALVE-CHEST CORES.

The joint in the flask is made level with the face of the frame flange, the drag rammed up, lifted off, finished and blacked. Short pieces of wood of the exact thickness of the flange are laid on the overhanging parts as an additional support, and the drag lifted back and bolted to the flask, the board cramped up and the whole turned over and laid flat on logs.

The ramming up of the top part of the pattern is then proceeded with, the main part of the cope being first rammed to the top. Then the shallow box is bolted to it and the whole rammed level. The gate pegs, 1¼ in. round, are fixed in the two corners nearest the main barrel. The cope is well vented over the pattern area, lifted off, the pattern drawn and the mould finished, blacked and stoved. The mould should require no further venting, and with a good pattern very little finishing.

Special care is taken as to the position, size and shape of the gates. These are lead from the down gate half-way round the barrel prints at each end. Wide, flat in-gates about 5 in. by 1 in. are cut to the mould in such a position that the two incoming streams of metal do not meet but pass each other, thus ensuring a continual flow of metal from and to end of the barrel (see Fig. 2). This sweeps away all dust, gas, etc., from underneath the barrel core, the part which experience shows is most likely to be dirty or spongy. As all the metal which enters the mould has to pass through the gates, these should be finished and blacked with as much care as the mould itself.

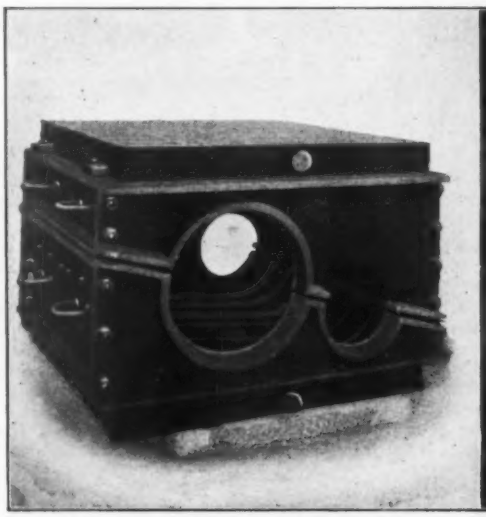


Fig. 8.—View of Complete Box.

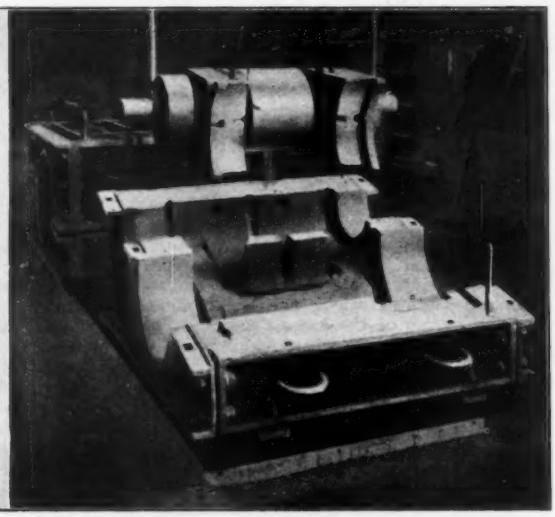


Fig. 9.—Valve-box and Passage Cores being Lowered into Mould.

Coring Up.

When the mould is thoroughly dry the bottom half is taken from the stove and laid on logs. The flask is eased off the drag, the wooden supports removed and the moulds cleaned and blown out with compressed air and the drag fastened to the flask with ¾-in. diameter bolts.

The two lightening cores between the barrel and frame flange and the main part of the exhaust core are first fitted in their prints in the frame flange. The latter core is supported in position by two studs placed between it and that part of mould towards which it leans and all three are secured by hooks hung on the core-irons which pass through the vent holes in the prints and project beyond the drag, to which they are packed.

The two small lightening cores between the barrel and the valve box, and bottom piece of the steam inlet are put in, and the mould is then ready for the valve-box and passage cores. These are fitted together outside the mould with the 4-in. round hole in each, directly in line. The holes in the passage cores are filed out a little on the side towards the main barrel. This allows a little clearance between them and the barrel core and prevents any danger of a crush. A straight barrel of 3½-in. gas-pipe slightly tapered at the ends, about 18 in. longer than full length of cores, is then threaded through the 4-in. hole in each core. Holes are drilled in the barrel to correspond exactly with the vent outlets in the cores and also for cotters (Fig. 6). The whole set of cores is then slung in the crane by the barrel, the passage cores being supported by bands and placed in position, Fig. 9.

As the main barrel core cannot be lowered vertically into the mould with the passage cores in their proper position, these are lifted (they slide round the 4-in. barrel quite easily), and lowered with it. The cores are set correct by the passage cores, being packed up to the barrel core with two studs behind each. Two cast-iron washers (Fig. 6) are placed on the barrel against the cores at each end of the valve-box and the whole cottered together. There is little danger of any metal getting between the core joints and into the vents, as the iron barrel chills it directly it comes into contact with same. A joint, ⅛ in., may with impunity be left open. Only six studs are used in each cylinder. As these are a fruitful source of leakage, especially when placed at the top of a casting, the value of the 4-in. barrel, combining as it does a rigid, reliable core support with a perfectly safe, free vent outlet, will be readily appreciated. The mould is then closed, bolted, and joints rubbed up with loam.

Preparation for Casting.

The pit is dug out to the required depth, the necessary channels cut in the bottom to clear the

core packing and vent, and the mould lowered in. Then pipes are connected to all the vent outlets and the box rammed round with sand. The gates and risers are then made up. As the in-gates are situated rather low down in the mould, a high head of metal is required to fill the mould with the necessary rapidity. Gate cores, 5 in. diameter by 5 in. thick with a 1¾-in. round hole through the centre, are placed over the down-gates. A cast-iron runner box about 18 in. high, made in two parts, is fixed over the cores and a gate capable of holding about 8 cwts. of metal is formed. The risers are made up to the same height as the runners. This is better than running them off level with the box into "pigs," as the iron in the mould is under greater pressure. This gives a slightly closer grain and helps to eliminate blowholes in the casting.

Casting.

About 38 cwts. of iron are required to fill the mould, gates and risers. A ladle is reserved specially for casting cylinders. This must be kept perfectly clean and thoroughly dried. The method of casting is similar in principle to that of casting steel ingots. Cast-iron egg-shaped stoppers (Fig. 7) are fitted in the gate cores. All slag, coke, etc., is skimmed off the metal before teeming. When the iron is judged to be of the right temperature, which is far better on the "hot" side than the "stiff," it is teemed till the runner is nearly full. The stoppers are lifted out and the gate kept at the same height till the metal appears in the risers. Pouring is then instantly stopped until the gates and risers are at the same level. Another cwt. or so is then poured in until they are full. No feeding is required unless the metal is "lively" in the risers. When the casting is set the iron in the runner box is tapped out into pigs through a 2-in. hole left in box close to the bottom. This iron, together with gates, risers, etc., takes the place of ordinary scrap in a future cylinder charge.

With castings of such an intricate and complicated design as a modern locomotive cylinder it is practically an impossibility for the designers to conform in all parts with the laws of crystallisation, segregation and contraction. The difficulty generally occurs at the junction of three or more walls of metal each of which crystallises and contracts at different angles, the junction also forming a "pocket" of metal which remains liquid rather longer than the surrounding portions. Although the fracture of these parts as a rule would reveal no flaw to the naked eye, nevertheless they often show a pronounced leak under the hydraulic test. These defects can be considerably minimised, if not altogether removed, by lightening out the corners at the points of contact with small cores, as shown in Fig. 1. These holes do not detract, but on the contrary rather add to the strength of the parts affected.

Fig. 8 shows a complete set of moulding boxes. This view was taken with the box upside down so as to show loose bars bolted in the cope to clear the top half of the pattern. Fig. 9 shows the valve-box cores threaded on the barrel ready to be lowered into position in the mould, also the small lightening cores and bottom piece of the exhaust core in position. Fig. 10 shows the valve-box cores in position, also the barrel core, the mould being now ready to have the cope lowered on. Behind this mould is the mould of another cylinder almost ready for the flat barred piece of the box to be bolted on to finish ramming up of the cope. The gate pegs can be plainly seen in the corners of the box. Fig. 11 shows a dressed casting ready for machine shops.

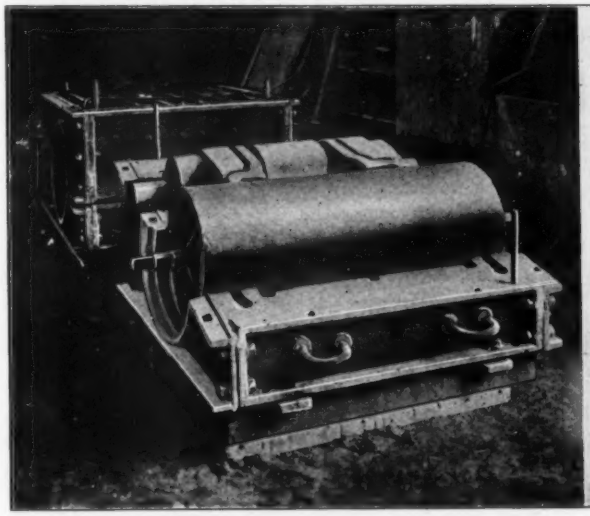
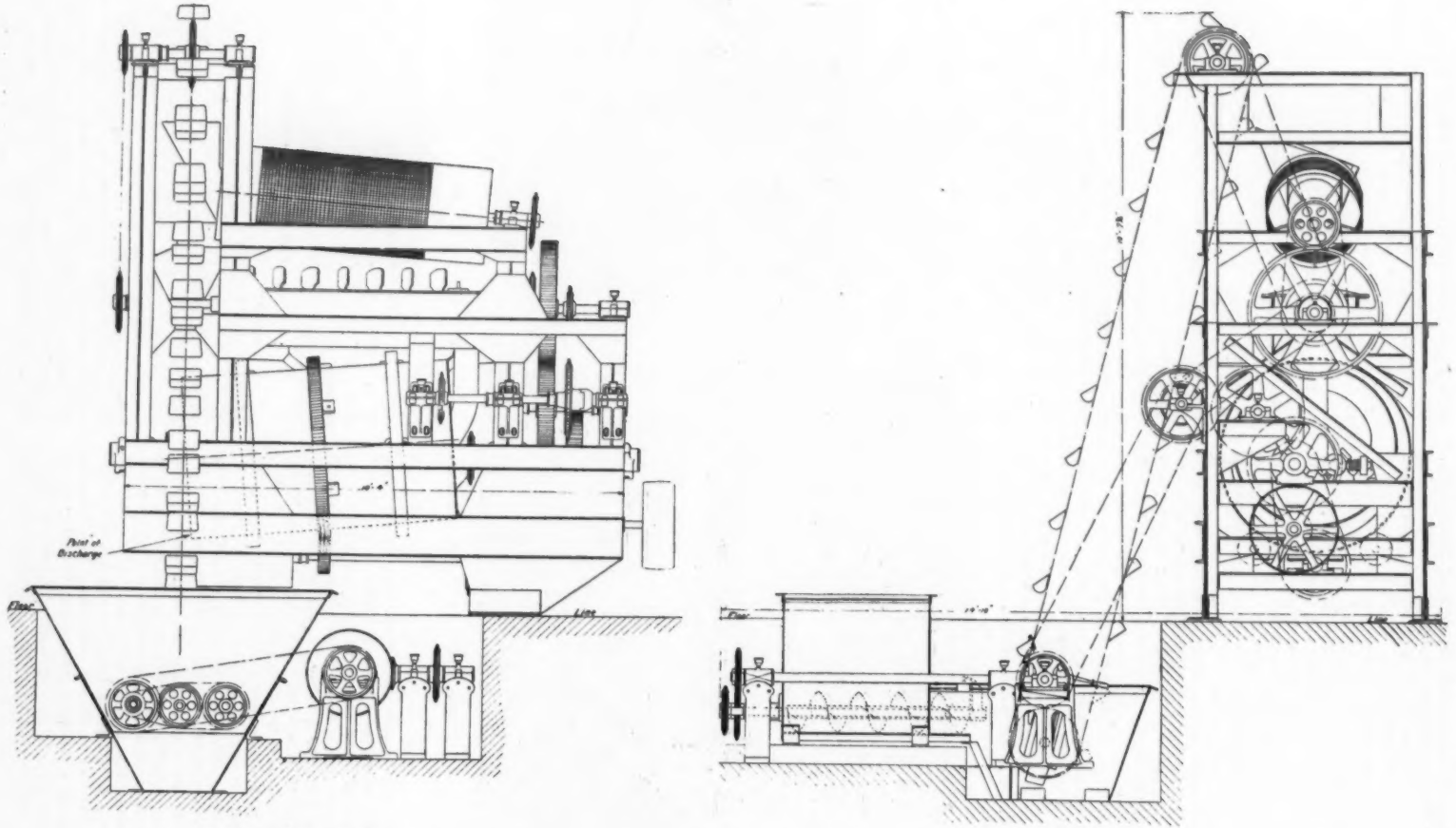


FIG. 10.—CORES IN POSITION FOR CLOSING.

FIG. 11.—FINISHED CASTING READY FOR MACHINE SHOP.

A SCHOLARSHIP will be offered for competition among graduates of the North East Coast Institution of Engineers and Shipbuilders in September next. The scholarship is tenable for two years, and is of the annual value of £50. It will be awarded on the results of an examination held in Newcastle, simultaneously with the matriculation examination of Durham University, in the following subjects:—(*a*) English. (*b*) Mathematics. (*c*) Experimental Science. Every candidate shall be a British subject and a member of the graduate section of the Institution of not less than one year's standing; and shall have served or be serving an apprenticeship on the North East Coast. The successful candidate will attend a college in the district.



FRONT ELEVATION. END ELEVATION.

FIG. 1.—PROPORTIONING, SCREENING, MIXING AND BLENDING MACHINE FOR FACING AND CORE SANDS; CAPACITY, 8 TONS PER HOUR.

Machinery for the Treatment and Mixing of Sands and Moulding Materials.

By Algernon Lewin Curtis, M.E.

(*Continued from page 529, Vol. 16.*)

A very suitable type of plant for proportioning, screening, mixing and blending quantities of green sand or core mixtures is shown in Fig. 1. This style of machine may be installed with advantage in the scheme shown in Fig. 2, page 526 (FOUNDRY TRADE JOURNAL, August 14), or it can be used in a foundry independently. The machine, which was designed by the writer, has a capacity of 8 tons per hour, and requires 8 h.p. to operate. The top of the proportioning hoppers being arranged 6 in. above floor level, side-tipping trucks or steel wheelbarrows may have their contents easily dumped. The end elevation in Fig. 1 shows the method of elevating the proportioned ingredients of a facing-sand mixture preparatory to screening. This latter operation is carried out by a circular mechanical screen, sufficiently elevated at one end to receive sand from its shute, also to allow the gravitation of refuse downward to a further shute placed for its reception at end of the screen. The mesh of the screen is made large enough to prevent clogging by damp sand, but at the same time is not large enough to admit lumps of iron, refuse, etc. As the mechanical screen revolves sand passes through it at the point of its lowest arc, falling by gravitation into a U-shaped mixing trough placed immediately below. In the centre of this mixing trough works a shaft having attached to it a number of blades or paddles, which form the pitch of a screw. These paddles are set to work at such angles on the shaft that any desired feed can be given to materials being mixed or cut over; and the sand as it is propelled is ultimately forced out into a convenient shute placed at the end of the U-shaped mixing trough.

It is advisable to have a pneumatic spraying device fixed over the mixing trough, so that water or organic matter in solution can be sprayed on to the sand during the process of being mixed or cut over. This ensures a uniform moisture content, which is most important in a facing or core-sand mixture.

Underneath the U-shaped mixing trough is placed a cylindrical steel drum, one end of which is slightly elevated to receive sand coming from the shute attached to the trough. Inside this drum, working in a horizontal plane, are placed a pair of steel rolls; while fitted to the drum's interior are a number of lifting blades or paddles which receive and deliver sand to the rolls as it comes from the shute of the mixer trough. The drum revolves on a pair of tyres fitted at each end, which work in flanged trunnions placed in the framework of the machine. Between the tyres on the outside of the drum a segment bevel wheel is fitted, which is driven by a corresponding pinion working on a lay shaft below.

The speed of the rolls is such that sand entering the drum is passed and repassed through the rolls a number of times to each revolution of the drum. One rolls travels faster than its fellow, and ensures a kneading action, analogous to the kneading of a strong clayey sand into the body of a sharp or old sand. The faster roll works in sliding spring bearings, so any desired pressure can be obtained for adjusting the temper of a sand mixture. The chief wearing parts in the above machine are the mixer paddles or blades, and these can be replaced at a small cost.

Fig. 2 shows a small type of this machine. When installed the hoppers of the machine are let into the floor. In some cases it may be impossible to arrange a mechanical screen on the top of mixing machine through lack of room in the foundry. Where this occurs a mechanical screen may be placed over or in the vicinity of the feed hoppers. If old sand is screened on the foundry floor, it may be carried and dumped direct into the hoppers of the machine as shown in Fig. 3. As it often happens that the treated sand requires temporarily storing preparatory to use, this is accomplished by elevating the finished

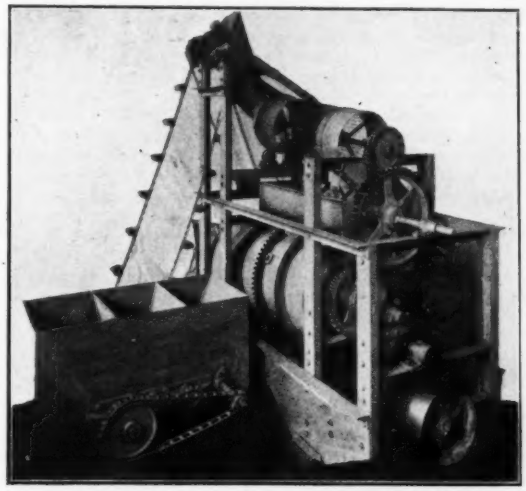


FIG. 2.—SMALL TYPE OF SAND-TREATING MACHINE.

product into storage bins, as shown in Fig. 3. This plant is capable of treating four tons of sand per hour, requiring approximately 4 h.p. to operate.

Some founders may think it unnecessary to roll sand in order to "temper" a first-class facing mixture, and consequently consider machinery of the above type superfluous. As the question of "temper" is perhaps only imperfectly understood, it may be of interest to explain this more fully. "Temper" as applied to facing sand mixtures is the blending or balancing of the different or contrary qualities of each ingredient used. Selection of materials, of course, plays a prominent part in the ultimate operation of tempering, because a refractory plastic sand will naturally temper better than one of a weaker nature.

As the ultimate value of a green-sand mould depends chiefly upon its ability to transmit gases and heat from the molten metal by convection, consequently the temper of a facing sand is corelated to its porous property. If a facing sand is too strong,

it requires considerable mechanical venting, and will then probably scab; whereas if the facing is too weak it makes working difficult, and washing probably results. It is therefore best to try and strike a happy medium between the two consistencies, as a facing mixture of medium strength is the best to use, unless the raw sand itself possesses unusual porous qualities, in which case it can be used at its full strength. An untempered or badly tempered facing-sand mixture, however, will show altogether different degrees of porosity to one tempered to the proper strength. In a few cases Nature has prepared certain sand deposits, the natural consistency and porosity of which is remarkable. Such deposits, however, are most rare, as the structure of the majority of moulding sands is of such a character as to oppose rather than promote porosity and incidentally venting.

(To be continued.)

Bauxite for Refractory Goods.

In considering the question of aluminous refractory products, the first point is to examine the sources from which alumina in a technically pure state may be obtained. Two sources of supply are open, viz., bauxite, which is a natural product, and alumina hydrate and anhydrous alumina, which is a manufactured product. Alumina hydrate is, however, too costly a material to allow of its use except for special purposes, though both from a chemical and physical standpoint the material is eminently suitable for the manufacture of high-grade refractory products. Bauxite productions, unless burnt to a very high temperature, diminish indefinitely in volume, that is to say, continual contraction takes place. This defect, which was a very serious one, in fact, which sometimes seriously imperilled the stability of the furnace, is now no longer to be feared, says "The British Clayworker," thanks to the work done by various investigators and more particularly by the late Prof. Moissan. Bauxite as obtained in the raw state contains a high percentage of chemically combined water as well as a large quantity of moisture. As a result, manufacturers have found it desirable to calcine the material at a high temperature before incorporating it with the clay or other materials which have to be added in order that the mass may be moulded. From the point of view of refractory-materials manufacture there are two distinct types of bauxite available, viz., "white bauxite" and "red bauxite." The first type is akin to pure kaolinte in composition whilst the latter is much richer in alumina, but is also higher in iron oxide. The following analyses show the composition of each type, but these must not be taken as indicating that there is a definite division possible, as one type merges into the other.

	White Bauxite. Per cent.	Red Bauxite. Per cent.
Alumina	45	54
Silica	24	10
Iron Oxide	1	2·5
Titanium Oxide	4	6
Lime and Magnesia	0·25	0.5
Water	25	21

The refractoriness of the white bauxite corresponds to 3,200 F. and the red to 3,500 F. For all general purposes the use of white bauxite will give more satisfaction, but frequently goods are required in which the percentages of alumina must be abnormally high, in which case, of course, red bauxite must be used.

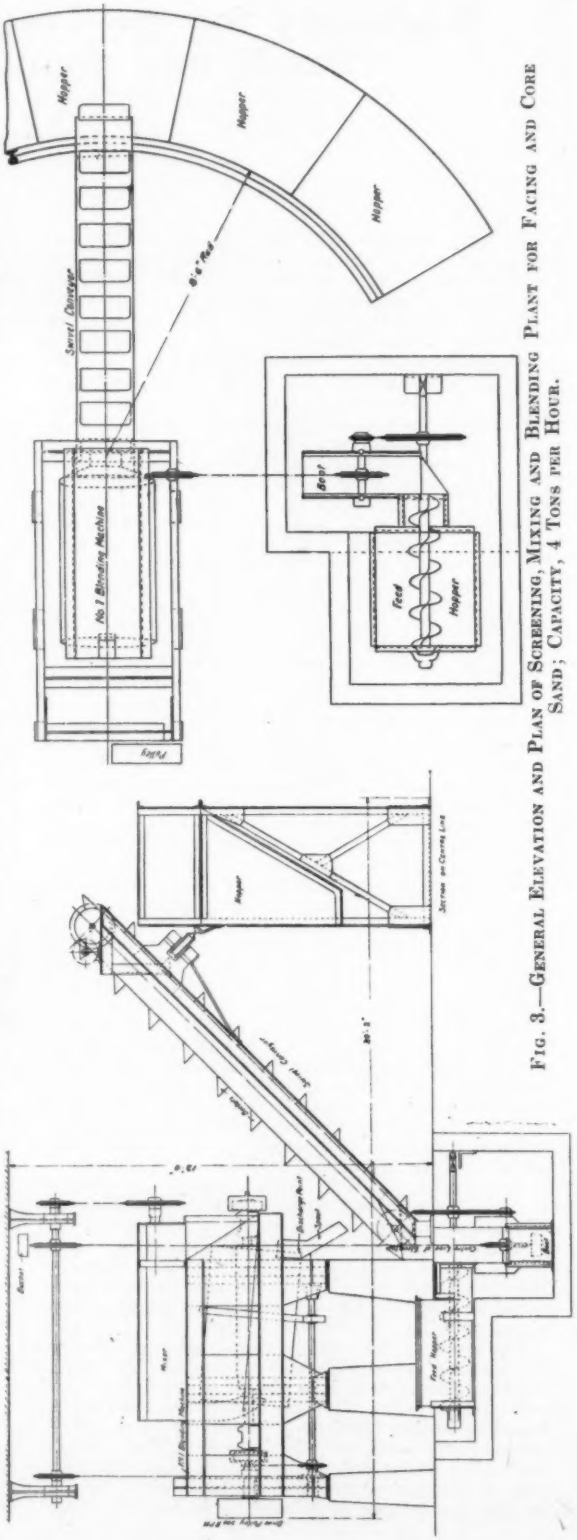


FIG. 3.—GENERAL ELEVATION AND PLAN OF SCREENING, MIXING AND BLENDING PLANT FOR FACING AND CORE SAND; CAPACITY, 4 TONS PER HOUR.

Eighteenth-Century Metal Work.

In the course of a Paper on this subject, read before a recent meeting of the Society of Arts, Mr. W. A. Young, having referred at some length to the practical side of bygone crafts, proceeded as follows:—

Before the days of steam three things were necessary to the establishment of a successful works: natural power, mechanical means of converting power into work, and air-blast. The situation of an ironworks was determined by the possibility of fixing a water-wheel. The efficiency of the works depended largely on the hammer. The quantity of material produced must always have been roughly proportionate to the number and quality of the bellows. These were considerations which, more or less modified, must have harassed every eighteenth-century manufacturer engaged in winning merchantable metals from native ores. It was not until Watt, Boulton, Cort, and the Darbys came to the front that rapid progress was made. It is curious to notice how the metal trades of our period were hampered because inventions lay undeveloped. Dud Dudley discovered the way to smelt iron with coal about 1619, but it was 1735 before the Darbys began to use coke freely at Coalbrookdale. Even then progress was slow in other places, and as late as 1788 charcoal was the fuel burnt in most of the Sheffield furnaces. It is a mistake to suppose that the steam engine rapidly replaced the water wheel. Twenty-two years ago I had a share in demolishing a water wheel that had supplied power for three generations in an engineering shop employing two hundred men. It drove the foundry blower, all the shafting in the machine shop and saw-mill, and a fan for eight forges. The weight of evidence proves that although Boulton and Watt made the manufacturer's decision easier when he had to choose his location, that decision still leaned towards a water site.

Until the foundry business was shifted from the South-Eastern Counties of England to the Midlands and Scotland, the casting of iron for domestic purposes seems to have been a singularly restricted trade. Cannon was the chief output, but firebricks and andirons must also have been made by the hundred. The irons served to support the wooden logs on the hearth, while the backs protected the brickwork from the fierce heat of the burning wood, and incidentally served to ornament the centre of many an English home. As soon as the more energetic Midlanders and Scotsmen took up the trade, they branched out in all sorts of ways. Thus we read that at Carron in 1784 the works were turning out kitchen ranges, which had been invented earlier than that by Bodley, an Exeter man, grates and stoves, kettles, teapots, saucepans and frying-pans, which are described as "neatly and solidly tinned." A quite superficial examination of a file of the eighteenth century patents has thrown a lot of light on the foundry trade of the period. Among other facts I have discovered that tumbling small castings in a barrel to brighten them is at least 150 years old.

If you will examine carefully the domestic ironwork of the seventeenth and eighteenth centuries at the Victoria and Albert Museum, you will reach the conclusion that I have reached—namely, that the work is honest hammer and anvil work. Those men used the drill sparingly, relying upon punches for holes, and fullers and sates for fashioning the tenons that fitted them.

Passing on to copper and its alloys, it is clear that at the beginning of the period brass and bell-metal were used for making cooking utensils for the kitchens of the well-to-do and merchant classes. These were cast in the bell foundries, of which there were a large number in London and the provinces. It seems not unlikely that the decay of bell-founding in the eighteenth century was accelerated by the increasing encroachment of cast-iron cooking utensils. In London alone there used to be bell-founders in Shoe Lane, All Hallows in London Wall, Windmill Hill in Clerkenwell, Fleet Street and Whitechapel. There are only two such foundries left. That in Whitechapel has been carried on continuously since 1567.

The establishment of iron foundries in the Midlands, which were managed on factory lines, must have seriously affected the prosperity of the bell-founders. The rise of the brass-foundry trade in the Midland city is being investigated at the present time by a committee, whose editor is preparing a history of its rise and developments. Birmingham has been the home of the hardware trade for a very long period. In competition with Bristol and other centres where brassfounding was already established, Birmingham set out to win a share of the new business, with what permanent success her present position in this department of metal work attests.

The business attained big proportions, and in 1780 thirty casters of brass in the town were melting down a thousand tons of brass per annum. In that year the actual makers of the alloy advanced the price of ingots, and the casters had to pass on the burden by increasing their prices by 7½ per cent.—a step which was described as a "disagreeable necessity." That was in August, and on October 9 there appeared in "Aris's Gazette," a local newspaper, "a serious address to the merchants and manufacturers of hardware, and particularly the inhabitants of Birmingham and the adjacent towns." The writer, who signed himself "Bristol," spread himself to an inordinate length, but he made out a serious case against the smelters of copper and the makers of brass. The casters and their wholesale customers learned that "they are imposing on you an enormous advance of more than twenty pounds per ton on copper and upwards of thirteen pounds per ton on brass, without any other reason than that they presume on their power under such association, and that the same must and will be received tamely by you." The taunt had the desired effect, and "Bristol's" suggestion that a co-operative works for the production of brass should be started was taken up by the victims. A meeting was called in November to discuss the project, and in 1781 the new Brass and Spelter Company was formed with a capital of £20,000. Boulton seems to have taken a keen interest in the preliminary plans. Unfortunately the shareholders quarrelled with him when the site for the smelter came to be discussed. Boulton favoured Swansea. "If," he wrote, "the works are erected in Birmingham, the work will be constantly deranged by the interference of a hundred blockheads, and instead of being assisted, will be incommoded by every subscriber that chooses to take an idle walk by ye bank of ye canal." I confess I like Matthew's blunt style, and I am not surprised, when the local majority prevailed, that he resigned. All the same, I suspect he left his money in the concern, and became one of its best customers.

Studies on Cast Iron.—I.

By J. E. Hurst.

What is the cause of the variations in mechanical proportion of cast irons of identical compositions? This question has often been asked, and has not yet been solved satisfactorily. As yet no definite theory or explanation has been advanced which would bring these variations of tests within the control of the ironfounder or metallurgist.

In a Paper by Messrs. Cook & Hailstone, given before the Annual Meeting of the British Foundrymen's Association in September, 1909, a difference in mechanical tests of irons of practically the same chemical composition is there ascribed to a peculiar network structure of the phosphide eutectic and cementite, shown on etching deeply with 20 per cent. nitric acid. The authors further show that irons of the same composition and variable tensile strengths without the presence of cementite contain this peculiar network structure of the phosphide

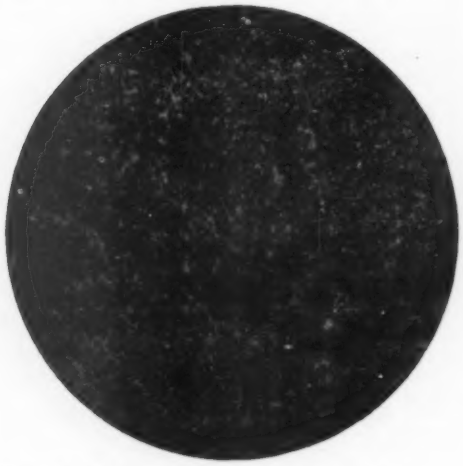


FIG. 1.—SAMPLE (*b*), THE LOW-TEST IRON. NOTE THE NETWORK STRUCTURE.

FIG. 2.—SAMPLE (*c*), INDISTINCT NETWORK FORMATION.

FIG. 3.—SAMPLE (*d*), WITH MORE DISTINCT NETWORK THAN (*c*).

FIG. 4.—SAMPLE (*e*). NOTE THE NETWORK STRUCTURE.

eutectic, the network being characteristic of the irons with the high tensile strengths.

Since this Paper, it seems to have become an accepted fact amongst certain ironfounders and metallurgists that this type of structure is indicative of high tensile strength.

The analyses, together with tensile results, of a number of irons selected from a large number of daily tests are recorded in Table I. herewith. The first pair of analyses (*a*) and (*b*), are in everything but phosphorus practically of the same composition, yet the high phosphoric iron shows an increase of tenacity of 50 per cent. over the low phosphoric iron. The second pair (*c*) and (*d*) are iron similar to (*a*), that is high in phosphorus, and, in fact, cast from the same mixture; the tensile results are 25 per cent. lower than (*a*), which can hardly be accounted for by the slight increase in silicon. The third pair (*e*) and (*f*) are two high phosphoric irons of practically identical composition, with the exception of the graphitic carbon, which is higher in the sample (*e*), yet they both have practically the same tensile strength.

All the irons examined were found to possess the network formation of the phosphide eutectic. The accompanying micro-photographs show the structures. In the photographs (*c*) and (*d*) the network structure in (*c*) is not so distinctly marked as in the remainder of the photographs, which fact in itself tends to emphasise the contention that it is yet too early to ascribe high tensile strength in cast iron to this network structure.

The samples are all taken from daily test bars, and one might account for these erratic tests by the variations in casting temperature, which varies daily, that is unless specially controlled. This may be true or not; but the fact still remains that the network structure of the phosphide eutectic is characteristic of both high and low tensile irons, and therefore one cannot definitely state that irons containing this particular structure will show high tensile strength. In fact, examinations of both tensile and transverse test fractures of cast iron show that the line of fracture bears no relation whatever to the distribution and structure of the phosphide eutectic, but rather to the graphite plates.

TABLE I.

No.	C.C.	Gr.	Tota. C.	Si.	Mn.	S.	P.	Tensile strength.
								Tons sq. in.
(*a*)	0.74	2.60	3.34	1.49	0.69	0.08	1.10	12.4
(*b*)	0.69	2.65	3.34	1.40	0.59	0.066	0.61	8.0
(*c*)	0.61	2.43	3.04	1.96	0.72	0.075	1.22	9.0
(*d*)	0.65	2.67	3.32	1.68	0.71	0.077	1.28	9.8
(*e*)	0.62	3.04	3.66	2.19	0.81	0.10	1.12	11.60
(*f*)	0.55	2.56	3.11	2.10	0.97	0.098	1.01	11.90

AT a meeting of the Imperial Advisory Council of the Institute of Industry and Commerce consideration was given to the best means of approaching the various Dominion Governments with a view to abolishing the payment of license taxes payable by British commercial travellers in the Dominions and colonies, and also to the best means of bringing about the standardisation of company law throughout Great Britain, the Dominions, and colonies, in order to facilitate commerce within the Empire. After carefully considering the proposals, the Council decided that a memorandum should be drawn up by the Institute, after consulting with the leading specialised trade organisations, and that this memorandum be submitted to the agents-general of the Dominions and colonies for submission to their respective Governments.

The Nickel Industry.*

BY ALFRED STANSFIELD.

It has frequently been pointed out that Canada produces two-thirds of the world's supply of nickel. Newspaper writers have demanded that the export of nickel matte from Canada be stopped and that the matte be refined in Canada, while the Dominion Government has been approached to see what can be done to prevent the ultimate shipment of Canadian nickel to Germany. As there are no facilities for refining nickel matte in Canada, a prohibition of the export of nickel matte would cut off the supply of nickel for the Allied Powers; and while Great Britain commands the seas, Germany cannot hope to secure Canadian nickel, even although it may be refined in the United States and may be shipped ostensibly to merchants in neutral countries.

It may be of interest in this connection to give a short account in outline of the nickel smelting industry. The main producers of nickel ore or matte are as follows:—The Canadian Copper Company at Copper Cliff, Sudbury, produces matte containing (for 1913), about 22,000 net tons (2,000 lbs.) of nickel. The Mond Nickel Company at Coniston, near Sudbury, produces matte containing (for 1913) about 2,600 net tons of nickel. La Société de Nickel and other companies produce in New Caledonia ores and matte containing about 8,000 net tons of nickel. As the production of nickel in France was only 1,900 net tons in 1912, it appears as if a large part of the ore or matte must have gone elsewhere for treatment. Norway produced in 1912 about 400 tons of nickel.

The matte produced in the Sudbury district contains on an average about 50 per cent. of nickel and 25 per cent. of copper. The Canadian Copper Company ships its matte to Constable Hook, N.J., where it is refined by the International Nickel Company, which controls the Canadian Company. The Mond Nickel Company ships its matte to its own refinery in South Wales, near Swansea. The matte and ore from New Caledonia is shipped in part to Havre in France and there worked up to nickel. The Norwegian ore is smelted to matte at Evje and refined at Christiansand. It will be seen from the above that the world's supply of metallic nickel is produced approximately as follows:—In Great Britain,† 2,600 net tons yearly; in France, 1,900 net tons yearly (both controlled by the Allied Powers); in the United States, 22,000 net tons yearly (restricted as to ultimate distribution in war time by British command of the seas); in Norway, 400 tons, probably available for Germany; and in Prussia,‡ 4,400 tons, available for Germany. Of the 22,000 tons of nickel produced in the United States during 1913, some 14,000 tons were exported, much of which must have reached Germany in preparation for the present war.§

Nickel steel contains as a rule from 3 per cent. to 4 per cent. of nickel, so that each ton of nickel serves for nearly 30 tons of steel. It is estimated that two-thirds of the world's production of nickel is employed in making nickel steel, which would indicate a production of nearly 600,000 net tons of nickel steel per year.

* From the Canadian Mining Institute Bulletin.

† This represents the matte received from Canada only.

‡ Prussia produced 13,000 net tons of nickel ore and 4,400 tons of nickel in 1912. The ore, however, would not contain more than 1,000 tons of nickel, so that the bulk of the 4,400 tons of nickel must represent matte or ore imported from New Caledonia or the United States.

§ Germany imported 3,600 net tons of nickel in 1913, and exported 1,800 net tons of nickel, and 15,000 tons of cobalt and nickel ore.

Malleable Iron Castings.

Before a meeting of the London Branch of the British Foundrymen's Association on January 22, Mr. A. Willis in the chair, the subject of malleable-iron castings was dealt with. Mr. H. O. Slater introduced the subject with a short Paper covering some of the practical considerations, and this was supplemented by the Branch-Secretary, who dealt with the technical and theoretical aspects of the work, and also gave illustrations and descriptions of the furnaces and ovens employed. Mr. Slater's Paper was as follows :—

Some Practical Aspects.

In dealing with a subject of this kind it is almost impossible to cover the whole of the work in a brief Paper, or to recapitulate and expound the various problems associated with the foundry's operations, as they are too numerous, though nevertheless interesting. Difficulties are met with in grey-iron founding, but in the malleable-iron foundry they are more numerous and altogether greater, owing to the fact that the product has to pass through two additional departments and processes before being classed as completed castings. The metal itself, also, is far more troublesome in its nature, having greater contraction and consequent "drawing" propensities, which require to be overcome by proper running and rising. Thickness and design of the casting also must be taken into consideration, for a pattern originally intended for grey iron may give endless trouble in a malleable-iron foundry, producing perhaps cracked castings, or, even if sound, castings which are of the wrong dimensions owing to excessive contraction. The two additional processes abovementioned are those of annealing and "setting."

Annealing is of great importance, but often presents many difficulties and is at times disheartening work, as so much depends on natural laws over which the operator has practically no control, but which he has to study and adapt as far as possible to his own ends. This unquestionably calls into play both resourcefulness and ingenuity. It is generally supposed that a moulder trained at grey-iron work can quite well take his place in a malleable cast-iron shop and work as efficiently as a man used to malleable work; but that idea is totally wrong, for a man who is not used to the class of work is "lost" as to the methods of running and rising, and has to be instructed by those in charge of the foundry to ensure good results. Some men grasp the idea a great deal quicker than others, but in any case most men are more or less "at sea" for at least a month after being introduced to "malleable" work. Fresh men, therefore, spell worry and extra work and responsibility for the foreman.

Moulding.—Since unequal thicknesses in castings cannot always be avoided, it is necessary to adopt means for densifying the metal in its thicker sections and regulating the solidification of unequal thicknesses so as to avoid cracking in the mould. Taking first the sand used, this must be as refractory as possible, consistent with its use for moulding purposes. Mansfield sand as the chief constituent of the mixture is suitable, with loam of a light nature and ingredients to give the highest porosity, which feature is essential so as to minimise the pressure of air in the mould. The progress or flow of "malleable" or white iron is much more easily retarded than that of grey iron, and it does not seem to have the same force in running as other metals. This feature necessitates particular attention being paid to the method of gating and pouring. The sand should be milled to give greater strength, especially in small work, as it saves time in sprigging and hooking to ensure a good lift or draw, and also gives a better skin to the casting.

Running and Rising.—There are several types of runners used, generally of a weighted spinning type. Risers if used should be large, very often taking two-thirds as much metal as the casting itself. This is necessary for securing dense and sound castings and for regulating the solidification of unequal thicknesses. The shape and size of the runners are arranged to the same purpose. The use of chillers is very often more successful in securing the desired results, and often the benefit is felt at the furnaces through less metal being required for a given amount of castings—an important point with crucible melting. Another feature of the use of chillers is that they will often be effective at places where a riser cannot be placed, though in some cases it is advisable to use both.

Cores.—Core sand is a most important consideration in the production of good castings. It must be of a mixture which is strong when dry, as most "malleable" cores are intricate and frail in design, but the core must also offer the least possible resistance to the metal in cooling; otherwise the casting may be caused to crack. Core-irons should be as small as possible. They assist the casting to cool, and this fact should be borne in mind when arranging for irons. Where dabbers are used on the core-irons the irons must be removed as soon as possible.

Melting can be carried out by several methods, employing respectively cupola furnaces, air furnaces or crucible furnaces, the latter being by far the best from a standpoint of quality, though not from the standpoint of cost, as the crucible process is the most expensive.

Installation of Annealing Ovens.—One important factor to be taken into consideration when laying down a plant or choosing a position for the erection of a malleable foundry, is the condition and nature of the soil. The back of an annealing oven has to bear practically a continual weight, while the other bears its share only when in actual operation. This necessitates the bed or foundation being either counterbalanced by additional weight or extended on one side to give a more even distribution of weight on the respective parts. On marshy land this precaution is absolutely essential. In such cases the annealing ovens are a source of trouble unless built above the level of the river or tributary causing the land to be marshy. The penetrating power of water sometimes surprises those with little experience of such cases; for the rising tide will sometimes force the water through bricks as though they were sponges, and also through concrete that one would at first think impermeable. This is only mentioned as a side issue, though an important one in installing ovens.

Annealing.—The casting coming from the mould is not treated in the same way as a grey-iron casting, for as soon as it is out of the sand the runners and risers are broken off while still hot (they break off easily at a certain temperature which a trained eye can judge), and the casting is then placed in a muffle, which is built on the same principle as an annealing furnace, and allowed to cool gradually. The annealing which follows is very important, and for this process the castings are packed in a mixture of iron oxides—iron-ore—according to the shape and thickness of the castings, the strength of the new ore being regulated by suitable additions of

old or used ore. Difficulties are experienced in annealing where the work is very varied unless facilities are available for treating one class of work in one oven, as the treatment should be more or less varied according to the weight and design of the castings. The hard castings are placed in iron pots and treated much in the same way as a pattern is in a moulding box, iron-ore being rammed round. This ore both affects the carbon in the metal and prevents to some extent the distortion of the castings during the annealing heat-treatment. Considerable judgment has to be exercised in selecting castings for the same pot and same mixture of ore, while watch must also be kept on the commercial aspect of the operations. The castings, like animals, seem to have different temperaments, tendencies and habits, and require to be studied to determine what treatment shall be given and in what direction they are likely to be distorted, so that they may be suitably packed to produce only that which will be easiest to correct.

When the oven fires have been lighted the temperature necessary to produce the change in the condition of the metal must be attained and kept regular throughout the whole period. The temperature is controlled by means of dampers and flues at the side and should range from 1,100 deg. C. to 1,200 deg. C. An experienced eye can judge accurately enough—this with all due respect to the use of scientific instruments.

The ovens are built of firebrick with an arched roof, and are stayed with cast-iron tie-rods to keep the bricks in their place during expansion and contraction caused by heating up and cooling of the ovens.

"*Setting.*"—This process also calls for a deal of ingenuity, but is very often reduced to a minimum by judicious packing in the annealing pans; though even this minimum accounts for a great deal of the foreman's time. One can well imagine the trouble experienced with an intricate casting such as a steering-gear box or case, which has been even only slightly distorted in the process of annealing, and has to be brought up to its correct dimensions so as to drop accurately into a jig for machining, this being the general practice in machine shops to-day. The method adopted for this "setting" is to make a mould from the pattern, then make a block or jig from the mould so as to form a duplicate of the pattern, on which block the distorted casting can be placed and pressed into shape either by a press or by a hammer, the latter being very hard and hot work since a casting of any considerable thickness has to be made hot to facilitate the setting to correct shape.

At the conclusion of the Paper, Mr. Slater exhibited a number of specimens of both hard and annealed castings, and explained the characteristics of each. Some duplicate castings of respectively hard and annealed irons showed admirably the ductility produced by the process, while an aeroplane-engine cylinder exhibited was very interesting, as indicating the possibilities of the malleable cast-iron process when properly conducted under efficient supervision.

Some Technical Aspects.

Following Mr. Slater's address, the Branch-Secretary dealt with the more scientific and technical aspects of the subject, discussing first the distinctions, both chemical and physical, between the Reaumur or European process and the black-heart or American process, the irons employed in each of the processes, and the effects on the mixtures of different melting processes. The excessive shrinkage of white iron was illustrated by reference to typical cooling curves of grey and white irons respectively, and it was explained that in annealing the original contraction was often partly compensated for by expansion due to the separation of the carbon to the temper form.

The design and operation of various classes of melting furnaces—crucible, cupola, open-hearth, and air furnaces were next discussed, which subject is dealt with on another page of this issue. The construction and operation of annealing ovens was then considered, and the speaker proceeded to explain more closely the phenomena of annealing, involving decarburisation and change in chemical condition of the remaining carbon. Stress was laid on the importance of slow cooling through the critical range of temperature—between about 740 and 860 deg. C.—in order to permit the separation of the carbon, which apparently took place through that range.

Discussion.

The CHAIRMAN having opened the discussion,

MR. J. W. WORRALL asked for further information on the expansion and contraction during annealing. Was the ultimate contraction or the partial expansion from the size of the original casting influenced by the packing? He had found that in some instances the casting would contract in one direction and expand in another.

MR. STONE said that this was partly to be accounted for by the packing and partly by the temperature of annealing. Often an inexperienced man would cause trouble by wrong annealing temperatures. As to the value of steel turnings in the annealing ore, on which a question had been asked, they were of absolutely no use in annealing the European product.

MR. GORDON asked whether it was not usual for pattern-makers to allow uniformally $\frac{3}{16}$ in. contraction on patterns for "malleable"; the Secretary had stated that owing to the annealing expansion a pattern-maker could often work on the normal $\frac{1}{8}$ in. contraction for grey iron.

MR. H. G. BARRETT asked what coal was preferable in annealing ovens.

MR. SLATER, in replying, said that distortion and irregularities in contraction could frequently be attibuted to the method of packing. It should be remembered that at the annealing temperature the casting was in a semi-molten condition, in which state a light casting under a heavy one might well become unduly distorted and stretched in parts. With careful packing in the ore-annealing process, however, $\frac{3}{16}$ in. was a fairly accurate allowance for total contraction. He mentioned one case, however, in which one of two brake pans had expanded in annealing apparently nearly $\frac{1}{2}$ in., while the other had recovered $\frac{1}{8}$ in. of its original $\frac{1}{4}$ in. contraction Only by careful study of the peculiarities of the castings could distortion and contraction be properly regulated, and then it was necessary to arrange as far as possible for that distortion to take place which would be most easily remedied. He confirmed Mr. Stone's statement that steel turnings, ashes and other packing were useless in the European process.

The SECRETARY, also replying, made reference to the question of packings. The function of the ore used was twofold, first as a protective medium and second as an oxidiser of the carbon in the metal; in performing the latter function it gave up part of its oxygen, thus changing from ferric-oxide (Fe_2O_3) to ferrous-oxide (FeO), in which condition it ceased to act as more than a protective medium. While other packings might be iron oxides,

unless they were capable of parting with some of their oxygen they were useless. In black-heart practice, however, the packing required only to afford efficient protection, as the annealing was effected almost entirely by heat. With reference to the question of expansion during annealing, it was quite true that in European practice $\frac{3}{16}$ in. was usually allowed. The remark regarding the expansion of $\frac{1}{8}$ in. during annealing applied more strictly to American practice, where decarburisation was practically absent, and the separation of the carbon caused the expansion in question. Such expansion also occurred in Reaumur iron, but not to the same extent, and might be negligible or absent when the annealing was such as to cause excessive decarburisation, as the resulting ferrite structure would naturally not be less dense than that of the original white iron.

The meeting concluded with a hearty vote of thanks to the lecturers.

British Foundrymen's Association.

Sheffield Branch.

The annual meeting of the Sheffield Branch of the British Foundrymen's Association was held on Tuesday, January 26. Mr. T. H. Firth (Branch-President) occupied the chair.

The SECRETARY, in the course of his report, said the membership again showed a substantial increase. During the year three Members, 20 Associate Members, and four Associates had been elected, and two full members had been transferred from other Branches to Sheffield. On the other hand, two Associate Members and one Associate had ceased to be members. The number on the Branch register at the present time was 130. Three members of the Committee, Messrs. W. H. Hatfield, D.Met., H. Bagnall, and J. T. Goodwin, retired by rotation. All were eligible for re-election. The resignation of Mr. F. H. Knowles left a vacancy to be filled. Mr. Samuel Osborn (Vice-President of the Branch) had been invited to accept the Presidency for 1915, but replied that owing to his present obligations he was unable to accept. The financial statement showed that the year opened with a balance in hand of £13 0s. 7½d. The receipts included requisition £5, subscriptions £64 16s., and the expenditure £13 7s. 4d.; £64 16s. had been paid to the General Secretary, and there remained a balance in hand of £4 13s. 3½d.

The report was adopted.

MR. J. G. CROWTHER proposed the re-election of Mr. T. H. Firth as President. He said Mr. Firth had made an excellent President during the past two years. In that time the membership had grown by 57, which was the largest increase they had had.

MR. JOHN LITTLE seconded, and the resolution was carried unanimously.

MR. FIRTH, in reply, said he felt that he ought to resign after holding the office two years, because he believed that a change was good. However, when he was asked to take the office for another year, he said he should be pleased to do so.

The PRESIDENT then proposed that Mr. J. G. Crowther and Mr. John Little should be the Vice-Presidents.

MR. J. R. HYDE seconded, and the resolution was carried unanimously.

MR. W. SHEPHERD proposed the re-election of Mr. R. W. Kemlo as Hon. Secretary and Treasurer. He said they would have to go a very long way before they could get a secretary to equal Mr. Kemlo. They all knew to what a large extent the burden of work rested on a secretary, and Mr. Kemlo had filled the office admirably.

MR. H. BAGNALL seconded, and the resolution was carried with heartiness, MR. KEMLO acknowledging his re-election. Other officers elected were as under :—Auditors, Messrs. W. Oxley and J. R. Hyde; Committee, Messrs. W. H. Hatfield, H. Bagnall, and J. T. Goodwin; representatives on Council, Messrs. John Little and R. W. Kemlo.

MR. F. DARLEY then read a Paper entitled "Some Notes on Screw Propellers," which was illustrated by lantern slides. This Paper will be dealt with in our next issue.

Annual Dinner of Newcastle Branch.

The annual dinner of the Newcastle and District Branch of the Association was held at the Collingwood Restaurant, Newcastle-on-Tyne, on January 30. Mr. J. M. Weir (President) occupied the chair.

After the usual loyal toasts had been honoured, MR. WM. MATTHEWS, of the Wallsend Slipway and Engineering Company, Limited (in the absence of Mr. R. Wallis, Past President), proposed the toast of "Our Association." After referring to the objects of the Association, he said a great deal had been heard lately of the Germans' wonderful efficiency and the way in which they had applied science. The Germans had undoubtedly got ahead in the application of science to industry, but our countrymen were making up lee-way. He commended the work of the Association and appealed for an increased membership.

The toast was honoured with enthusiasm.

The CHAIRMAN, in responding, said that whatever the Germans could do, they could not manufacture guns nor turbines for driving the ships better than Englishmen could.

COUNCILLOR E. SMITH, South Shields, gave the toast of "The President," which was cordially honoured.

The health of the visitors was drunk on the proposition of MR. M. E. GALLON, Senior Vice-President.

PROFESSOR LOUIS, Armstrong College, responded to the toast, and expressed appreciation and pleasure at meeting the gentlemen present, especially as he was the representative of the department of Durham University which concerned itself with the scientific side of the work in which the members of the Foundrymen's Association were interested. That department was endeavouring to assist in solving the problems which vexed the lives of the foundrymen. Regarding the Germans, he admitted that they had applied a great deal of science to their work, but he asked those present to remember that since the discovery that it was possible to smelt iron, and the invention of the forced blast, ironworkers and ironmakers were not indebted for a single invention in the direction of Germany, but what had come out of our own little island. That, he thought, showed that not only was there a sufficiency of scientific ability in this country, but there was also originality and ability to apply it. The war had upset their points of view very much in many respects, and it had forced upon him the reflection that has been uppermost in many minds, that while the science and organisation displayed by the Germans was a very fine thing in its way, character was something better.

The health of the Secretary, Mr. H. A. J. Rang, was proposed by MR. J. SMITH, who expressed appreciation of the services rendered by Mr. Rang.

Foundry Management: Commercial.

By "Erimus."

Prime Costing.

In a previous article I dealt with the preparation of an estimate. Costing is more comprehensive as it is twofold. Costing is done first for invoicing purposes and to check estimates; and, secondly, to provide data for future reference. The former may be termed "Prime Costing," and the latter "Manufacturing Costing."

Fig. 1 shows the prime-cost "tree" and its branches. To arrive at the prime cost of a job it is necessary that the amount expended in its manufacture be readily accounted for and in conjunction with the "estimate form" suggested in a previous article (FOUNDRY TRADE JOURNAL, October, 1913). I will deal with the system adopted to record the expenditure. Books should be so arranged that the actual wages expenditure on a job can be ascertained weekly. In connection with jobbing foundry work, "wages" absorb from 40 to 45 per cent. of the total expenditure, hence the necessity of having a good system of time-recording. The system adopted by the writer is as follows:—A "Bundy"

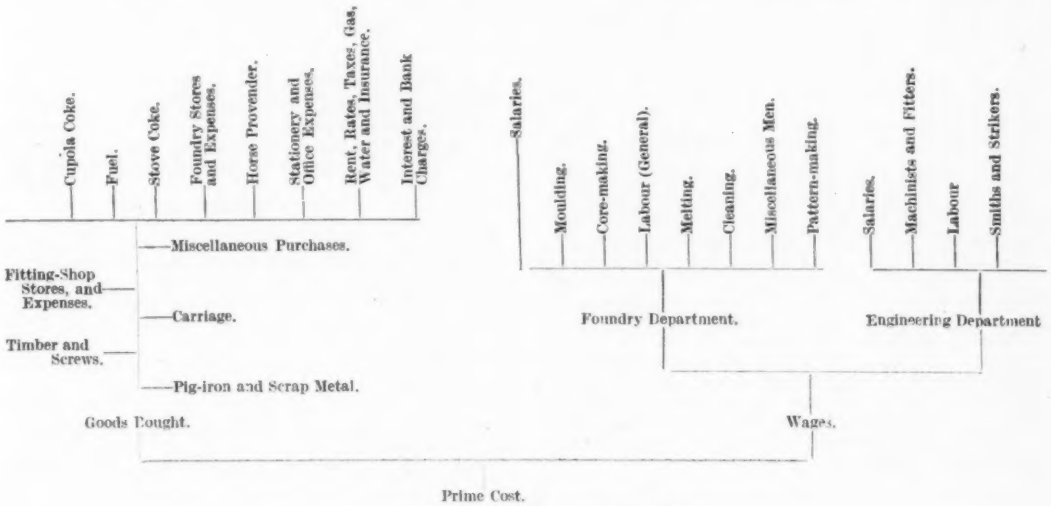
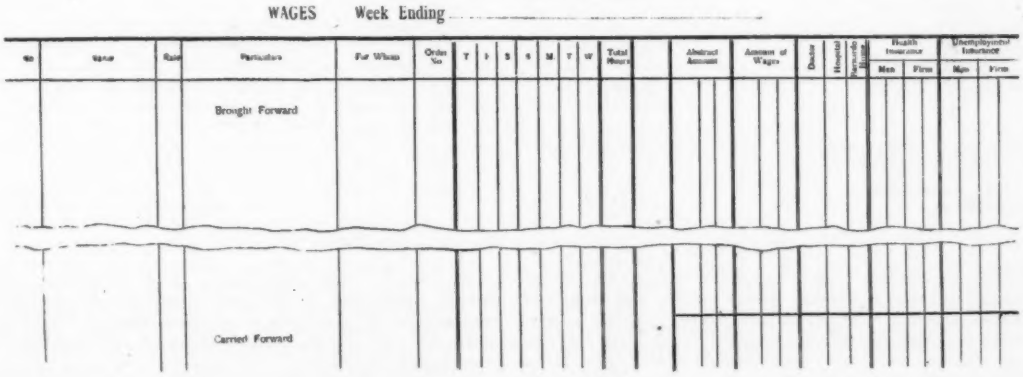


FIG. 1.—PRIME-COST "TREE" AND ITS BRANCHES.

FORM I.—*Wages Sheet.*



time recorder is installed at the work's entrance and each man and lad on entering "rings up" on the clock which records, on a paper tape, his number and the exact time he enters, and on leaving the

works he "rings up" again. The time is taken off the clock tape into a small time-book the following morning, and while this is being done a boy goes round with another book to each skilled workman and apprentice and obtains from them the time spent on each casting or set of castings the previous day. This is checked by the foreman, and if it agrees with the clock record it is duly entered on the wages sheets. Form I. is a copy of the wages sheet. At the week-end the wages sheets are added up with the number of hours worked on each job, and these are worked out at the rate per week and money value placed in the abstract column. The total hours are also calculated ready for the pay at the week-end. The amounts in the abstract column are transferred to the Order-Cost Book weekly. Form II. is the ruling of the Order-Cost Book.

After the wages are abstracted each week into the Order-Cost Book and deliveries are marked off (this being done daily), the total cost to date is added up, and, if the order is completed, the cost per ton of manufacture is worked out and put in red ink in the separate columns.

cast as well as the weekly weight of castings made, saleable castings, tools and plant being kept separate. This book and the wages abstract book also are dealt with later.

To revert to "Prime Costing," having obtained the skilled labour and made provision for arriving at the average cost of unskilled labour and salaries, attention may be paid to the materials. Metal may be taken at market price plus 5 to 7½ per cent. for waste in melting for jobbing foundry work and about 2½ to 4 per cent. for special chair and pipe foundries where cupolas are working all day long. The writer favours "market" price rather than "purchasing" price, as if one buys, say, 1,000 tons of pig-iron and has to run the risk of the market, one naturally looks forward to making a profit on the risk if the price of pig-iron goes up, knowing that if the market price comes down, the customers will want their castings cheaper as the price of pig-iron falls.

Timber, screws, etc., used by pattern-makers should be accounted for by the foreman. If patterns are made specially for the job the full cost should be charged, but if existing patterns are used, such as for pipes, a small percentage of the original cost might reasonably be debited to the job to enable a renewal of the patterns to be made when it has done duty as long as is consistent with getting good castings from it.

FORM II.— *Order Cost Book.*

Date.	Order No.	Their Order No.	Name of firm and Description of Goods.	Price.	Deliveries.				Wages.					
					Date and No.	Cwts.	qrs.	lbs.	Moulding.	Core-making.	Smith work.	Patterns.	Machining or Fitting.	
									Wages abstracted from Wages Sheets or Book Weekly. When job is finished totals in these Columns may be transferred to Cost Sheet or Cost may be figured up in Extension Column.					Extension Column for making up Cost if separate Cost Sheets not used.

In connection with "wages" expenditure, all skilled labour is debited direct to the job from the wages sheets. Unskilled labourers', cupola men's, fettlers', and miscellaneous men's time and salaries are still to be dealt with, and for this purpose a wages abstract book is kept. The ruling of this book is dealt with under "Manufacturing Costing."

When taking the men's time the boy also makes a list of "castings made," and this is entered in a book specially ruled for recording the total daily

General and Establishment Charges.—As wages, pig-iron and patterns run away with about 80 per cent. of total expenditure, the balance of material and expenses may be grouped under this heading and the same will include cupola coke, fuel, stove coke,

FORM III.—*Wages Abstract Book.*

Week ending	.....19..			.....19..		
Good Castings made	Tons. Cwts. Qrs. Lbs.			Tons. Cwts. Qrs. Lbs.		
	Wages.	Cost per ton.	Percentage of Total.	Wages.	Cost per ton.	Percentage of Total.
FOUNDRY DEPARTMENT:—						
Moulding						
Core-making						
Labour						
Melting						
Cleaning						
Miscellaneous Men						
Pattern-making						
Salaries						
ENGINEERING DEPARTMENT:—						
Machinists and Fitters						
Labour						
Smiths and Strikers						
Salaries						

rent, rates, taxes, gas, water, insurance, foundry stores, stationery and office expenses, bank charges and salaries. The average cost of these should be taken out periodically and the jobs debited according to the amount of work and nature of same. For general work the average cost might safely be taken at, say, 30s. to 35s. per ton, but for loam and dry-sand work, which often extends over several days and takes more stove coke for drying purposes, the daily superintendence of the work being also greater, from 40s. to 50s. per ton may not be too high a figure to debit the job with under this heading. In the course of events there will naturally be a lot of low-class and heavy uncored work which is made in a much shorter time than the above, and as this does not take any stove coke and only a little supervision, the figure to debit the job with might range between 22s. 6d. to 25s. per ton.

The abstract of purchases is dealt with later.

Carriage or Carting.—This charge will either be the railway rate or a carting charge of 1s. 6d. to 2s. per load per mile for local traffic.

Painting and Paint will not cost more than 2s. 6d. per ton.

Cost of Tests will vary according to the demands of the inspecting engineer.

Manufacturing Costing.

Each founder's costs will vary according to the plant and power (steam, electric, or manual) employed. The writer will only deal with the latter, as only hand-power cranes are available at the works under consideration.

When dealing with "Prime Costing" it was pointed out that wages took from 40 to 45 per cent. of the total expenditure, and explained how skilled labour was dealt with by direct transferring to the Order-Cost Book for individual costs. As average costs of production are needed, we abstract our wages expenditure weekly under the following headings:—Form III. shows the ruling of the Wages Abstract Book. It would be utterly impossible to charge unskilled labourers' time direct to the jobs, as in a busy shop a labourer might be on nearly every job for a short period every day, and the clerical work involved in time-keeping would be greater than it would be worth. Foundry work varies in different shops, and the labour incurred will vary accordingly. In "speciality" shops the boxes fixed might be in continuous use for weeks, whereas in a jobbing foundry the boxes used to-day must be moved to-morrow to make room for another job, hence the high labour charges. While the writer is not in a position to state the relative cost of steam, electric, and manual power, the latter has, however, many advantages. It can be used inside and outside the foundry and in any nook or corner. It can use hammers, shovels and riddles, whereas steam and electric power are generally transmitted through cranes on a fixed line of rails from which they cannot be taken. One disadvantage of human power as transmitted through cranes is that it is painfully slow.

In connection with the Wages Abstract Book, a chart on squared paper is marked every week showing the percentage of total expenditure, and to show the vicissitudes of jobbing foundry work. Fig. 2 shows the actual result of a year's working. These results may not be of much use to compare with other manufacturers' data unless it is known exactly how the wages are abstracted and which men in the works are included under the several headings; but they might be taken as a basis to work upon by any interested party.

From the chart it will be seen that while the expenditure on labour, melting, cleaning, and miscellaneous men are almost constant by percentage,

FORM IV.—*Purchases Journal.*

Expenditure for the month of.....19.....

Blank for any New Accounts.	Fixed Plant.	Tools.	Fitting Shop Stores and Expenses.	Patterns, Timber, &c.	Trading Accounts Miscellaneous Purchases.	Castings Sales Account.	Interest and Bank Charges.	Stationery and Office Expenses.	Rent, Rates, Taxes, Gas, Water, and Insurance.	Horse Provender and Stable Account.	Foundry Stores.	Carriage.	Fuel.	Stove Coke.	Cupola Coke.	Scrap Metal.	Pig Iron.	Date.	Name.	Description of Goods.	Price.	Wgts.	Abstract.	Total.	Ledger Folio.

"moulding and cores" and salaries show great fluctuations. As soon as the output falls, skilled labour drops and salaries rise out of all proportion to the average. One good maxim can be learnt from this chart, and that is, "keep the foundry full of work," so that output can be got to keep the standing charges, of which salaries are an item, down to the lowest possible point.

Regarding the expenditure on materials, as accounts are only dealt with monthly and to save unnecessary clerical work, the Purchases Journal can be used for personal accounting and abstracts made for the Impersonal Accounts. The latter may be divided into as many headings as are required,

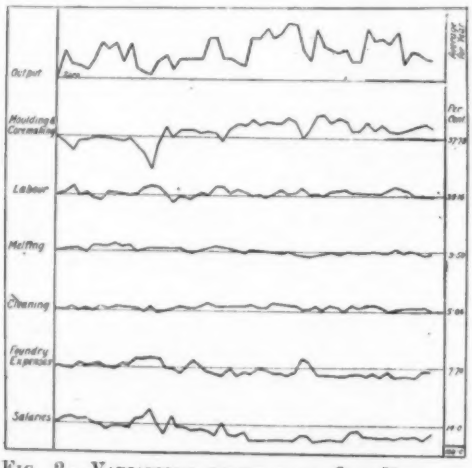


FIG. 2.—VARIATIONS THROUGHOUT ONE YEAR OF PERCENTAGES OF TOTAL EXPENSES, COMPARED WITH AVERAGES FOR PREVIOUS YEAR (SHOWN BY STRAIGHT LINES).

and while the cost of some items of expenditure are not generally required separately it is advisable to have as many sub-headings as possible to detect leakages. Form IV. is a ruling of the writer's Purchases Journal. The accounts are posted in the Personal Ledger to the credit of the several parties from whom purchases have been made, and the totals in the abstract columns are duly transferred to the debit of the accounts in the Impersonal Ledger. It is necessary to arrive at fairly accurate results to make out a monthly profit-and-loss account, and this entails stock-taking at the end of each month to arrive at the consumption of materials. This causes a great deal of trouble in taking approximate stocks, posting, and abstracting, but time thus spent is saved at the yearly balancing-up. The information gained is invaluable, as it is known how the concern is going, and at the same time valuable data is stored up for future reference and guidance. It is emphatically worth the trouble.

FORM V.—*Castings Made Book.*

Castings Made. Week ending .....19....

Thursday.			Friday.			Saturday.			Monday.			Tuesday.			Wednesday.				Saleable Castings
Ord. No	Description.	Wght	Ord. No.	Description.	Wght.	Ord. No.	Descriptions	Wght.	Ord. No.	Description.	Wght.	Ord. No.	Description.	Wght.	Ord. No.	Description.	Wght.		Weight.
																		Thursday ...	
																		Friday	
																		Saturday.....	
																		Monday.....	
																		Tuesday	
																		Wednesday...	
																		Total	
																		Additions to Tools and Plant.	
																		Total	
																		Grand Total	

The Castings Made book, kept in conjunction with the Wages Abstract book, is as per ruling shown in Form V. Saleable castings are entered under their order numbers with the actual weight when cleaned and fettled, and provision is made for recording the additions to plant and tools.

Having made provision for getting the weights of castings made and the expenditure on wages and material, it is a simple matter to divide the weight into the money value and get the "per ton" costs The following is a typical result:—

Weight of good castings sold .. .. .. 740 tons.

			Per ton.		
			£	s.	d.
Moulding and Core Making			0	17	8
Labour Charges General Labour		11 0			
	Melting (including Engineman)	4 0			
	Cleaning	2 11	1	1	7
	Miscellaneous Men (Smith and Striker and Box Fitter) ..	3 8			
Charges—	Cupola Coke	4 4			
	Fuel	2 4			
	Stove Coke	1 6			
	Rent, Rates, Taxes, &c. ..	2 9			
	Stationery and Office Expenses	4 5	1	8	3
	Horse Provender and Stabling Account	1 7			
	Foundry Stores, &c.. ..	5 10			
	Interest and Bank Charges..	0 2			
	Salaries	5 4			
Pig-iron and Scrap			2	17	11
Patterns			0	3	2
Carriage..			0	1	8
Average Cost per ton of Good Castings sold ..			6	10	3

(NOTE.—This is a 26 weeks' result. It was taken out a few years ago.)

Making a Cone Pulley in Skin-dried Green Sand.

By A. Sutcliffe.

The tackle first to be made for this job includes grids for lifting between the arms and a bottom plate to lift out the centre. The pulley illustrated is often made in loam, but not often in a skin-dried mould with a backing of ordinary foundry floor sand. The writer made smaller pulleys of this description in this way some years ago, and they turned out very good, sound castings. The method was

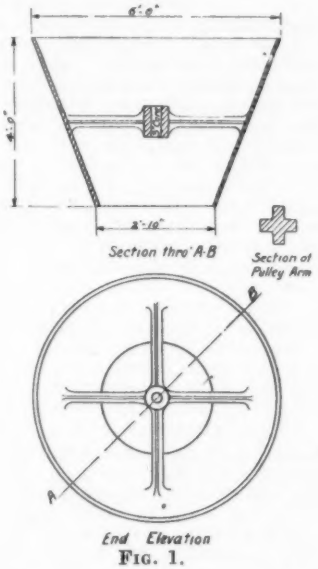


FIG. 1.

eventually tried with the larger one of the dimensions here given, with corresponding saving, in view of the amount of tackle and room that would have been required for loam.

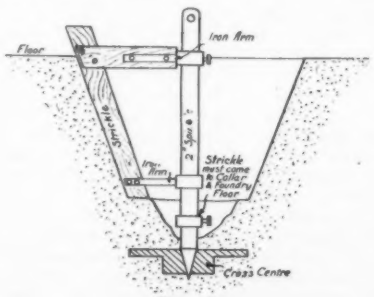


FIG. 2.

First a hole about 2 ft. square is dug in the foundry floor for the "dandy" plate. This hole is made 5 ft. 6 in. deep, and the sides are cut down to about 6 in. of the required diameter. The hole in the "dandy" is cleaned and the spindle with arms and strickle attached is inserted as shown in Fig. 2. The depth to which the strickle will work down is governed by the collar on the spindle bottom, and when it is brought down to that point the required diameter of the pulley at the floor level is obtained. After the sand has been cut and strickled to that diameter, fine facing sand is sieved in and rubbed on the face of the mould, the strickle being then run round again for the last time, completing the outside of the mould as in Fig. 3.

The spindle and board are then removed, and the bottom lifting plate is bedded in just below the rim of the pulley (Fig. 4). This plate has a bevelled edge and 9-in. long pins to steady it into place. To get the thickness of the metal for the rim $\frac{5}{8}$ in. thick strips wedge-shaped, 2-in. wide at top and

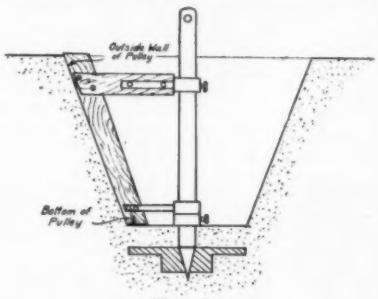


FIG. 3.

$\frac{3}{4}$-in. wide at bottom, are placed round as shown in Fig. 4. Ramming is then commenced and carried up to the arms, the core being well ironed to support its taper. Since the arms will only fit in their proper place, the moulder cannot go wrong. (It may here be mentioned that the arms are the only pattern-maker's work required for the job.) The arms are set (see Fig. 5) and the joint made, facing sand being placed between, after which the grids are claywashed and rammed in, ironing again being carefully done. Packing is put on the grids, and also the two "gits" on the boss as shown, and

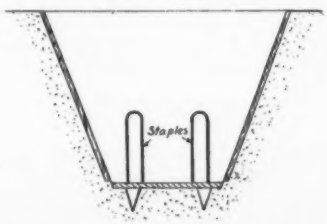


FIG. 4.

ramming continued to the top, the packing being carried up also.

The floor joint is then made round the outside of the pulley, and to save gaggering the top box, as the bars in the box stand short by 1 in., the outside edge of the box is dropped as shown in Fig. 5, leaving the bars within $\frac{1}{4}$ in. of the joint. The packing is scotched up to the box bars and the grids are hooked up between the arms with hook

bolts as shown. The top is then filled with black sand and rammed up. It will be seen that there is not a gagger in the job.

After the completion of ramming the nuts on the bolts are tightened up and the top lifted off and turned over for finishing, as shown in Fig. 6. After removing the arm pattern and any loose sand, the bottom of the core is lifted out on its plate, and stood on the three pins, when it is finished and wet blacked. The centre core is put in and the whole dropped into the stove carriage for drying over night. (It will get it out of the way to put it at once into the stove.)

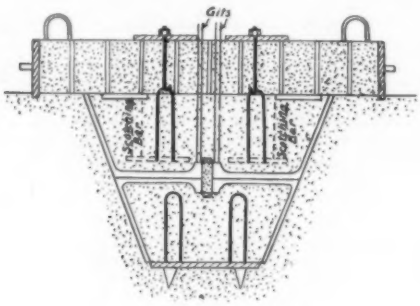


FIG. 5.

A board is then put in the bottom of the mould so that the moulder can get in and remove the strips. The mould is then sprigged with 2-in. sprigs just facing each of the four arms, to prevent the dash of the metal scabbing the outside. It is then given a good thick coat of wet blacking and trowelled, the marks afterwards being taken out with a little gum water.

To dry the job three fires are put in, one at the bottom on bricks and the other two hanging in the mould from a bar across the top. The top box is put over for the night so that both can dry together. The next morning the top is lifted off and logged up. The fires are lifted out, and all cinders and dirt removed from the mould. A rammer shaft is put down the taper holes in the

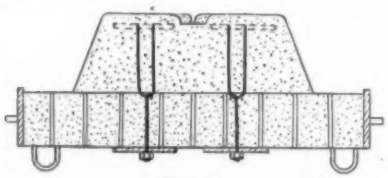


FIG. 6.

bottom so that the pegs of the plate will not meet with any resistance, and then all is ready for assembling.

The bottom half of the core is then slung up and put into place, and the top part follows. To get the air away from the rim a ¼-in. rod is put through the rim in the top part. The top part having been tried on and removed, it is put into place finally. In making up the runner a long runner box that comes to the edge of the moulding box is used, which gives a cleaner job and is better for the caster to get at. If the top is not bolted down it should be well weighted, as it requires and will stand plenty. The weight of the job is about 16 cwts., and the moulding takes about 28 hours.

The Foundry Chemist.

Before a meeting of the Halifax Branch of the British Foundrymen's Association, on Saturday, December 12, Mr. R. Carrick in the chair, Mr. A. Harrison, of Manchester, read a Paper on "The Foundry Chemist," which has already been published in our columns.*

MR. HARRISON said, at the beginning of his lecture, it was not his intention to trouble his hearers with the routine work of the foundry chemist or the foundry laboratory, but he wished to be considered as simply holding a brief for the foundry chemist, or, at least, for science in the foundry. Proceeding with a history of the founding of grey iron, the lecturer drew attention to the difficulty which moulders had to contend with when they had to grope their way with no knowledge of the materials they had to use—in fact, with nothing but hard experience to guide them. This, of course, meant that if they had to secure good results, if the first effort failed, they must try again, blindly, until success came. In conclusion, the lecturer said it was generally considered that molten iron contained all the other elements in a combined form, but that this was absolutely true he would not like to guarantee, for results which appeared to prove the opposite could be obtained with a suitable iron. For instance, a high-carbon, high-silicon iron, with low manganese, phosphorus and sulphur, if cast into very thin strips—so thin that the metal was cooled almost instantaneously—would most probably have very little above 0.3 per cent. of carbon in the combined form. To illustrate this, a sample was passed round which contained only 0.25 per cent. combined carbon. Such results opened room for the research chemist and in this research the help of the practical foundryman was sought.

Discussion.

The CHAIRMAN said the lecturer had given them a lot to think over and they had made out an admirable case for the chemist. Personally he thought the advance of the Germans in the production of iron and steel was due to the fact that they had made the best use of the chemist. He knew firms who previously to the war had bought their steel castings for motor cars from Germany and they found the utmost difficulty in obtaining steel castings of the same strength at a similar price, but he thought it did not apply as much to cast iron as to steel. He (the speaker) blamed the foundry owners for not having taken sufficient interest in the technical and chemical side of the foundry. It was the general practice to buy a lot of pig-iron by number, have it dumped into the yard without the least idea of its chemical analysis, then when an order came along with a specification demanding certain tests the foreman was absolutely "on his back"—he was expected to be something in the nature of a magician. Continuing, the speaker said he would like Mr. Harrison's opinion as to what took place under certain conditions in foundry practice. It was an actual fact, no matter what the analysis of the iron was, the action taking place after the metal had been poured into the mould had a determining effect on the nature of the casting. Of two castings of the same metal, one cooled quickly and the other slowly, one would be hard and the other soft, and by judiciously regulating the rate of cooling by the use of denseners, it was possible to use the same ladle of metal for castings of various thicknesses and get a perfectly uniform and strong iron as the result. A microscopical examination

* See *Foundry Trade Journal*, May, 1914.

showed the structure where denseners had been used to be of a network formation, and this structure was found in all strong irons. It was a fact that in this way a much cheaper pig-iron could be used and definite good results obtained. It would also be interesting to know what the cost would be of keeping a chemist. In a town like Halifax where there were many small foundries, he would like to suggest a chemist might be supported jointly by several firms. With regard to the samples which the lecturer had shown of thin strips of iron with only 0.25 per cent. combined carbon, he would like to know the amount of graphite and total carbon. Further he would like to know if all the metalloids in cast-iron were in combination with the iron when in a molten state. It was an important point, because if some of these metalloids were not in combination when the iron was molten the results might be a great deal different.

MR. HARRISON, in reply, said, with reference to foundries not being able to afford the upkeep of a chemist, he thought the idea of combination was a good one, and he thought it would be quite practical for a given number of shops or a district to employ a chemist for their common use. He suggested making use of the technical college chemist. He was sure if founders of cast iron wanted information about steel and malleable castings they would have to be prepared for the expense of research work and the use of the chemist, as the people who made these castings were very secretive. It was generally conceded that all metalloids were in solution when iron was in the molten state, though it was sometimes stated that all the carbon was not in solution, as some of the graphite contained did not melt in the cupola. But it was easier to believe that all metalloids were in combination.

MR. ROBINSON said he was quite in accordance with the lecturer in regard to the usefulness of the foundry chemist, but he did not quite agree with Mr. Harrison's remark that had it not been for the chemist the foundng of grey cast iron would have been like an engine without petrol, stationary. Grey cast iron had been manufactured for about 100 years, and the chemist had only played a part in its progress for 35 years. The science of practical experience had certainly done a considerable amount of work in the first 70 years. Also he would like to say that grading by fracture could not be absolutely useless, for the simple reason it had served its purpose for a long time, and in many cases was still serving its purpose. He had been at firms where the blast-furnace manager graded all his irons by fracture, and the results were so good that it was possible to pour castings for five months at a stretch with iron brought straight from the blast furnace. Blast furnaces had in times past been erected in the vicinity of ironstone mines, and it was an easy matter to produce pig-iron of a standard quality so long as the ironstone used was all obtained from that particular district, but as time went on and the mines either partially or wholly worked out, the blast-furnace people were under the necessity of procuring supplies from other sources, and the result was it was essential to take an analysis of the pig-iron in the foundry yard. Without doing this it became impossible to work with a minimum cost and maximum efficiency. In respect to the remarks about test bars, where different results had been obtained from two bars exactly alike and poured at the same time out of the same ladle, the main cause was that one of the gates was cut shorter than the other, causing one to be filled more rapidly, which, being cast hotter, was consequently the better bar of the two. He would suggest having test-bar patterns on a plate, when there would seldom be any variation. He would like to raise a question regarding the differences in quality of pig-iron, which were not always revealed by chemical analysis. Whenever they heard of an analysis being taken, it was given as almost complete, but never actually complete. The usual elements, carbon, silicon, sulphur, phosphorus and manganese were quoted, in the quantities present, these five being the vital elements to the founder, along with passing reference to the rarer but commonly-known impurities, such as nickel, cobalt, titanium, etc. But was there something else? It was known that the physical properties of the iron were determined by the state of the carbon and the quantity of other elements present in the iron; now if there should be any other element present in the iron (as yet undetected) which had an effect on the state of the carbon, that element might make a great deal of difference and account for the confusion which the lecturer and Mr. Carrick had mentioned as being in the minds of the foundry chemist, student and foundryman. He would like to ask Mr. Harrison why hot iron, and apparently very good iron, when leaving the cupola fell off very rapidly?

MR. HARRISON, replying, said that the cause of sluggish iron was an excess of silicon in the iron. Referring to Mr. Robinson's remarks, he said that science might have been used and at the same time might not have been applied by the chemist. He did not say that the 35 years of the application of the foundry chemist to grey cast iron had saved it from stagnation. The word he used was not chemist, but science. He did hold that but for the introduction of the chemist there would have been no theory. With regard to the firm mentioned, where the daily practice of grading pig-iron by fracture took place, he could not call a blast-furnace manager an unskilled man, and it was quite an unusual thing for managers to do that kind of work. They never did get a complete analysis of pig-iron; they got almost, but never an absolute analysis. There were many other elements present in small quantities, and they could only know their effect by persistent research.

MR. CARRICK remarked that when denseners were used the carbon was more of the nature of annealing carbon. It was neither combined nor graphitic; it was amorphous, and they had proved that they could get malleable properties by means of denseners.

MR. ROBINSON asked if the samples shown were not misleading? Were they not what were commonly known as freaks?

MR. HARRISON said the samples certainly were freaks, but nevertheless they were all of the same composition of iron, and the makers knew these differences existed, but sold it for the same, No. 1, or 2, or 3, as the case might be.

ELECTRIC FURNACES FOR SALE BY THE STEEL CORPORATION.—The Steel Corporation, which controls the Héroult electric furnace in the United States, is offering to steel manufacturers completely-equipped units of 1, 2 and 3-tons capacity. These furnaces are being built at the Pencoyd plant of the American Bridge Company. Heretofore, the licenses only have been granted and the manufacturer so authorised has had his furnace built and equipped under private contract, in accordance with the plans furnished. This plan continues to prevail with regard to the larger furnaces, but the smaller units may now be purchased all ready to be set up. The Steel Corporation has sold a three-ton Héroult furnace to the Electric Steel Company of Indiana, which has established a plant at Indianapolis for the manufacture of small castings for automobile and railway service, etc.

Melting Processes and Furnace Construction for Malleable Cast Iron.

The selection of the most suitable type of furnace for operation in a malleable-iron foundry calls for a careful consideration of all the factors involved; for what might prove the most economical furnace in one plant might be discounted in another plant by reason of greater or less quantity of metal required, irregular production, or difference in class of material produced. The question of initial cost of installation, too, is often a controlling factor, particularly in cases where the early stages of a foundry's operation will probably only witness a small output. The founder has a choice of the crucible furnace, the cupola, the air-furnace, and the open-hearth regenerative furnace, each of which has some feature, commercial or technical, to recommend it.

The Crucible Furnace is relatively cheap to instal in small units, is easy of operation and regulation, and has the important advantage that the metal does not come into contact with deleterious matter from the fuel. This furnace thus ranks as one of the best from the standpoint of purity of product, and since it can be operated either singly or in batteries of from two to any requisite number, it is

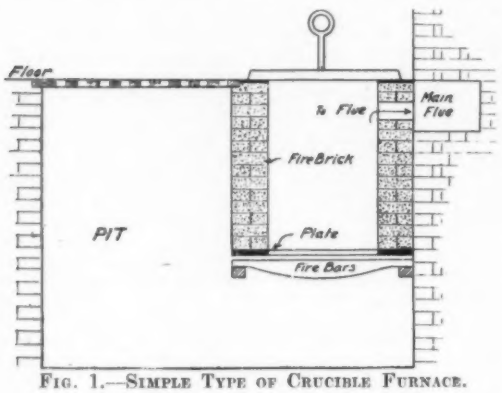


Fig. 1.—Simple Type of Crucible Furnace.

capable of dealing with a wide range of work. The chief drawback to its adoption is the high cost of operation, for the fuel consumption is greater than with either the cupola, the air furnace, or the open-hearth. There are several variations of the standard type of crucible furnace which may be adopted, including gas- and oil-fired, some accommodating a number of pots, and the tilting and detachable forms of single-crucible furnaces with or without fixed pots. These will be discussed in detail later. Despite the high cost the ordinary crucible furnace still finds many advocates and users.

The Cupola Furnace, familiar to the founder of grey iron, also has the advantage of being relatively cheap to instal, and is an efficient melter, requiring a fuel supply of about one part by weight of coke to four or five parts of metal charged. It has the serious disadvantage, however, of melting the metal in direct contact with the fuel, so that impurities—in particular, sulphur—are to some extent absorbed during the process. Since the composition of the metal is closely related to its suitability for malleableising, and since also sulphur is one of the most objectionable impurities when present over a low percentage, the cupola cannot be ranked as a first-class melter for this work. In fact, the low sulphur requirements for good black-heart malleable cast-iron practically rule out the cupola for that process; but in European or ore-annealing practice a much higher sulphur content is permissible, and thus we find the cupola furnace adopted by many founders producing a general quality of malleable-iron castings.

The Air Furnace, the melting apparatus which has hitherto found greatest favour in American practice, offers the advantages of higher efficiency as compared with the crucible furnace (when properly operated, higher than the cupola also), and less detrimental effect on the metal as compared with the cupola. The fuel used is usually a good bituminous coal, which does not come into direct contact with the metal, and the melting operation allows of a considerable refining or reduction of the silicon content by oxidation, thus allowing a wider range in the material charged and a better regulation of the product than in cupola working. The operation of the air furnace, however, calls for much greater skill and attention, while the installation of the plant is also a relatively expensive matter. Where large outputs of good metal are required this furnace commands careful attention as possibly being the most suitable style to adopt.

The Open-Hearth Furnace has of late years come into greater prominence in malleable cast-iron foundries, but as it was essentially developed for steel-making, and consequently large outputs, the design and operation of small units such as are required for malleable-iron founders have not received much attention. For many years it has been held that the high cost of installation and maintenance, the necessity of continuous operation for proper efficiency, and the presumed low efficiency of small units discounted the furnace for all but very large outputs. These contentions are not strictly correct, for while the cost of installation and maintenance are relatively high, it has been proved that high efficiency can be obtained with comparatively small units, particularly when using oil fuel; and when the coal consumption of 1 to 6 of metal (which is obtained in good practice) is compared with that of other furnaces, and the quality of the metal also is considered, it appears that a much wider adoption of the open-hearth will be witnessed in the future. It must, of course, be borne in mind that the use of this furnace necessitates the installation, maintenance, and operation of a gas producer, unless oil fuel is adopted—a practice which will doubtless receive much greater attention in America than in Great Britain.

Crucible Furnaces.

The crucible furnace for malleable cast iron does not differ in its essentials from that employed for other classes of work. The construction of a simple form of the furnace is shown diagramatically in Fig. 1, and is similar to that of the brass-founder's crucible furnace, the minor variations common to such furnaces being permissible in those for malleable cast-iron work.

Plumbago crucibles are usually employed, as for brass founding, the sizes ranging according to requirements, but being limited, of course, by con-

venience of handling. A pot that will hold 50 or 60 lbs. of molten metal is a useful size, but where the size of work being cast is large, crucibles up to 150 lbs. capacity are suitable.

The fuel should be good foundry coke with minimum sulphur and after the bed has become incandescent it should be made up with fresh coke to bring the top of the crucible to about the line of the flue. The crucible is then placed on and the sides are packed with fuel in the ordinary way. As with other classes of crucible work, the furnace should not be over large for the size of the pot employed or there will be a wastage of fuel to no purpose. The draught must be keen, as a temperature of about 1,300 degrees C is required to melt the metal.

The charge should be broken up into suitable small pieces, and the correct proportions of pig-iron and scrap charged. After charging, the furnace cover is placed on and usually luted with wet sand to exclude cold air. The furnace is opened to charge further metal when that first charged has melted, and the crucible is then raised with the tongs sufficiently to allow the bed to be replenished with coke from the sides, and further coke is packed round. This process is repeated at intervals until the crucible is as full as required, the cover being luted each time the furnace is closed. The crucible should not be kept long in the fire after the requisite quantity of molten metal at the desired high temperature is

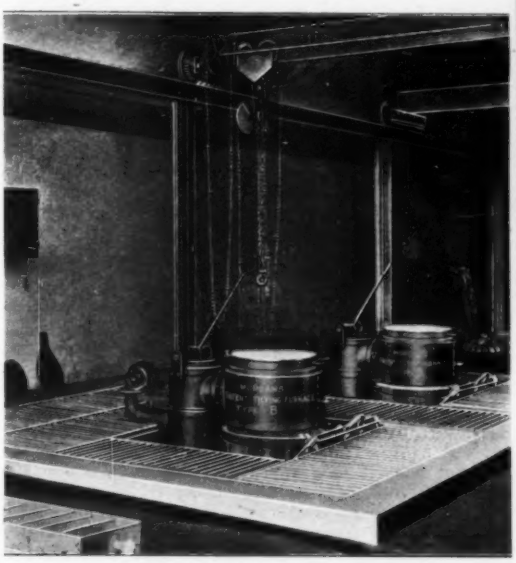


FIG. 2.—PORTABLE CRUCIBLE FURNACES FOR IRON MELTING.

obtained, as there is then a danger of oxidation. The high temperature, however, is necessary to obtain homogeneous metal; when cooler metal is required for heavy sections, it can always be allowed to cool off sufficiently.

Where considerable quantities of the metal are required, the furnaces are installed in batteries with a common ash-pit and flue, a damper being fitted to each "hole" to allow of individual regulation of the draft. The care and maintenance of the furnace, as in all crucible-furnace operations, is a vital matter from an economic standpoint, while in order to conserve the heat the crucible should be re-charged and put back on a renewed bed of coke (the bars being first cleaned) as soon as possible after pouring. It will, of course, be understood by founders accustomed to crucible work that the pots should be annealed before being put into the furnace for the first time, to prevent cracking. This can be done by either heating the crucible bottom-upwards over a coke fire or by placing it in position on a newly-lighted bed so that it heats up gradually as the fire burns up. Care of the crucible will greatly prolong its life, and this care must be extended to the handling with tongs, to ensure that the tongs fit and the crucible is not distorted by their pressure. With proper use and care a good crucible may last for 45 to 50 heats, though carelessness or poor quality may limit the life to less than 20 heats. The variations in the life of crucibles are somewhat startling until the causes of damage are appreciated.

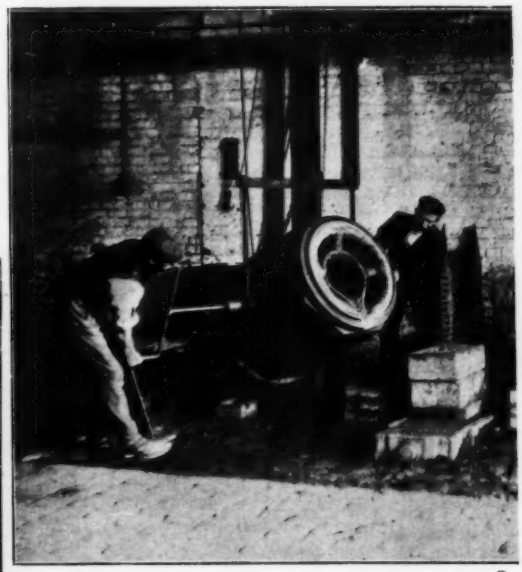


FIG. 3.—FURNACES DURING POURING.

Figs. 2 and 3 show a type of crucible furnace (by Morgans) used for melting grey iron, which suggests itself as suitable for malleable cast-iron work. The furnace body with the crucible and metal is transported bodily for pouring, whereby the loss of heat in transferring the metal to a ladle or shank is avoided and moulds can be poured at any point on the floor which is covered by the crane or runway. The furnaces shown are installed at the Birmingham Corporation's foundry for tramway castings.

A type of gas-fired crucible furnace which has proved efficient in the steel industry, and which should serve equally well in a malleable-iron foundry, employs the regenerative principle of the open-hearth furnace, the air and gas (or oil in some cases) combusting in a chamber containing several crucibles. Since this class of furnace, however, has not been adopted in malleable-iron founding, so far as the writer knows, it is not necessary to describe it here in detail.

Cupola Furnaces.

It is not necessary for the present purpose to discuss the construction and operation of the cupola furnace, since it does not materially differ from grey-iron foundry cupola practice. One of the chief distinctions is that it is preferable to adopt con-

tinuous tapping, as this prevents the accumulated metal in the well of the cupola becoming oxidised. Where large quantities are required the cupola with a forehearth has advantages, since it allows the metal to be held at a suitable temperature for a long while. The blast should not be at such a high pressure as for rapid melting of grey iron, or undue oxidation will certainly take place. In malleable cast-iron work rapid melting is usually bad melting; it is desirable only to raise the metal to that temperature that will allow the thinnest castings to be properly poured. These remarks, however, must not be interpreted to imply that sluggish metal is good; the rapidity with which white iron loses its "life" makes judgment of melting and pouring temperatures a matter for considerable care and experience, particularly since it is somewhat more fluid on leaving the furnace than is molten grey iron.

A fair fuel ratio for cupola melting is 1 to 4 or 5 of iron charged—a ratio which would be deemed poor for most grey-iron founding, but which does not appear to be improved upon without bad effects on the metal.

The chief objection raised against the cupola for melting for malleable cast iron, as stated previously, is that the metal is in contact with the fuel and liable to take up impurities therefrom, but in European or Reaumur practice when the furnace is intelligently operated it appears quite satisfactory for general work.

Air Furnaces.

Although the fuel ratio of 1 to 4 of metal, which is obtained with the air furnace, appears to be higher than in cupola melting, it must be remembered that the fuel is not coke but bituminous coal, which costs

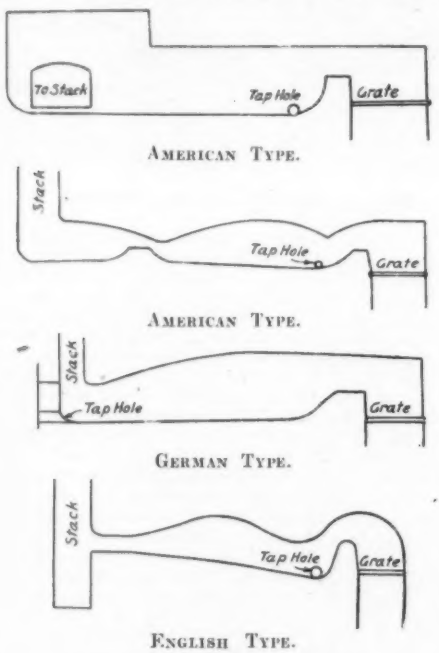


Fig. 4.—Examples of Air-furnace Roof Contours.

less than 75 per cent. of the price of coke. It must be admitted that in some foundries using air furnaces a ratio of only about 1 to 2 or 3 of metal charged is obtained, but this can be greatly improved upon by efficient operation, and in first-class practice 1 to 4 of metal can be maintained. A lot depends, of course, on the efficiency of the fuel, as well as the construction and working of the furnace. It is important to get the brick-work lining so hot that the radiated heat does the melting, and for this regular firing is essential. The furnace itself should be airtight, except at the correct entrance and exit for the air, or loss of heat will result. In firing, the coal should be piled at the door, and the latter then shut to allow the coal to coke slightly, and this should be carefully pushed over the whole area of the fire. This process should be repeated at regular intervals, so that practically a constant flow of gas is obtained from the coal. The air admitted in excess of the theoretical amount necessary to burn coal should not, according to Moldenke, be more than 25 per cent., and if that is allowed uniformly the necessary incandescence in the furnace to melt properly is obtained. If, on the other hand, the firing is done irregularly the melting is unduly prolonged. The first heat, starting with a cold furnace, necessarily consumes more fuel than successive heats, but firing as stated should give, with efficient furnace construction, a fuel consumption approaching the ratio of 1 to 4.

The melting should be as rapid as possible, or undue oxidation of the silicon in the metal will result. By regular melting the silicon can be reduced to the desired amount fairly consistently in each heat, while with rapid melting there will not be a serious discrepancy between the silicon at the commencement of tapping, and the end of the heat. Extended melting, further, increases the oxidation of the metal, and if this is excessive it is impossible, owing to the rapid setting of the metal, to pour sound castings.

As regards the construction of the furnace, it may be remarked that the hearth is generally longer than in the air furnace for non-ferrous work, while the flame is not allowed to come into such direct contact with the metal.

Designs of air furnaces vary very considerably as regards the contour of the roof, but the essential feature of reverberation is retained in each. As an example of a good air furnace reference may be made to the 12-ton furnace installed at an American plant and illustrated in our issue of November last. The hearth is 18 ft. 6 in. long, and tapers in width from 6 ft. 6 in. at the front bridge wall to 3 ft. 9 in. at the back. The firedoor for the firebox is at the side of the furnace near the front end, and has a hood and flue so that the smoke from the coal at the time of firing is carried away. The ashpit clean-out is at the front of the furnace. The rear end of the furnace is built through the wall of the building to a self-supporting stack outside. The air for the furnace is brought underground from a direct-connected motor-driven blower mounted on a concrete pier about 5 ft. above floor-level. This concrete pier is hollow and the air is delivered down through it. It is fitted with an extra opening at one side so that in cases of emergency a duplicate spare blower unit mounted on a track may be run up to the pier, the air and electrical connections made and operation continued almost without interruption.

So far the air furnace does not appear to have met with very wide approval in Great Britain, the cupola generally having preference. The impression has prevailed that air furnaces were only suitable for very large tonnages. This, however, is not strictly correct, for air furnaces of as little as 3 tons capacity can be operated efficiently. Probably an

equally influential consideration in restricting the application of such furnaces in this country, however, is the absence of the strict necessity for maintaining a low sulphur content in the metal which prevails in black-heart practice.

As shown in the accompanying illustrations, the apparatus consists of a firegrate, a hearth for the metal, covered with a refractory roof, and a flue and stack for maintaining the draft necessary for operation.

Foundations.—The foundations may be of ordinary brickwork or concrete as desired, since the furnace body is built of firebrick. At one end of the foundation the ash pit is arranged, the depth being usually from 3 ft. to 5 ft.

Fire Grate.—The grate should be of sufficient area to allow abundant air for the combustion of the charge, or poor melting will result, and the long period of retention in the furnace will harm the metal. Some typical ratios of grate area to area of hearth are as follows :—

Grate. Sq. ft.	Hearth. Sq. ft.
25	110
31	112
40	114
30	87
49	168
20	93

In some cases a forced blast is provided either beneath the grate bars or just above the bridge, or both. In such cases the ratio of grate area to hearth may be somewhat less. The grate bars are arranged that they may be drawn out for cleaning purposes. The roof of the grate end of the furnace may either be built solid or of "bungs," as explained later in connection with the crown or roof of the hearth. The fire-door is placed on one side of the grate in most cases, the ash-pit extending at the end sufficiently to allow access to the grate for cleaning and attention. The grate should be at least 12 in. below the fire-door to allow a bed of fuel of 12 to 16 in. deep.

It is advisable to have a heavy sheet-iron hood over the fire door, so that the smoke and fumes that blow out of it may be drawn off, and not contaminate the air of the foundry.

Bridge Wall.—Between the fire grate and the hearth is the bridge wall, which forms the retaining wall for the bottom, and also directs the furnace flames and gases over the metal. The bridge is of firebrick, the same as the body of the furnace.

Kane* lays great stress on the importance of correctly proportioned openings over the bridge walls, as on these depends the working of the furnace and the coal consumption. He advocates an opening over the front bridge wall of 18 in. to centre of bung and a back opening of 6 in. to centre of bung.

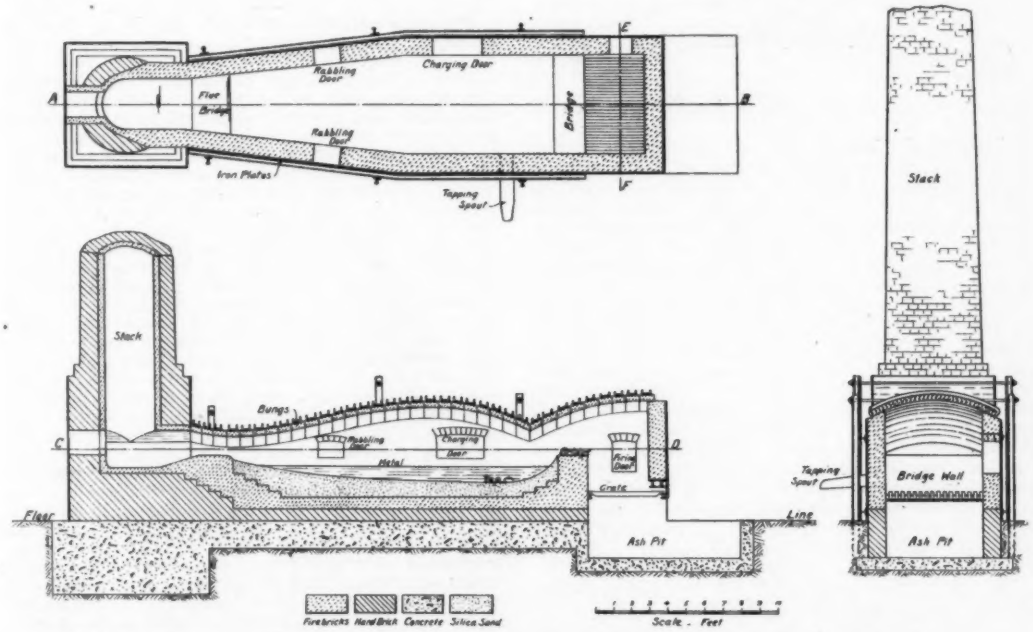


FIG. 5.—DESIGN OF TYPICAL MODERN AIR-FURNACE FOR MALLEABLE CAST-IRON FOUNDING.

Walls.—The firebrick walls are built within plates (which may be of cast iron), and retaining stays, the plates varying in size from about 3 ft. by 1 ft. to 8 ft. by 5 ft. The method of staying and building up is shown in the accompanying illustrations.

For daubing up the side walls and making the breast and spout, ground firebrick and fireclay mixed give very good results, and the same mixture may be used for lining ladles. Old grindstones, pulverised and rammed down hard, make a furnace bottom that will stand for several weeks.

At suitable points doors are provided, as shown, for skimming and rabbling the bath, and also for charging. Charging, however, may be done by removing bungs at the required points.

Bottom.—In preparing the furnace for the reception of a charge of metal, sand to a depth of 3 or 6 in. is well rammed down all over the bottom. The best sand to use is silica sand (practically pure silica),

* American Foundrymen's Association.

the British deposits of which are confined to Wales. Failing this, the sand should be as high in silica as possible, with such impurities as will not unduly reduce the fusing point. The thickness of the sand on the bed is sometimes varied according to the size of the heats, so as to keep the slag line as near as possible level at each operation. The shape of the bottom is such that the lowest or deepest point is at the tapping hole (of which there may be two, one on each side), generally just beyond the bridge, where the bulkier portions of metal are placed. Before

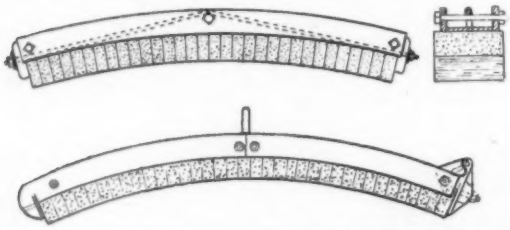


FIG. 6.—VIEWS OF TWO STYLES AIR-FURNACE BUNGS.

making up the bottom after constructing a furnace, however, a slow fire should be put in to dry out the walls and bungs of the roof. In repairing the bed all the sand is not removed, but only sufficient to remove all the adhering slag, and new sand is then rammed in. It is held by some that old firebrick ground up and riddled and mixed with sharp sand makes an excellent bottom.

The Roof or crown is of prime importance, for on its construction and its efficiency as a reverberator depends the heating effect on the metal. In air furnaces for some other work, as for example, non-ferrous metal melting, the roof is generally constructed with a pronounced dip just past the bridge, which has the effect of throwing down the flame on to the hearth at that point. While this concentrates the heat on the metal, it has the double disadvantage of cutting the roof or crown at that point and bringing the flame into direct contact with the metal. A longer hearth and flatter roof is therefore found advisable for malleable cast-iron work. Fig. 5 shows the design of a typical modern furnace.

The roof is not built solid, but is composed of a series of independent arches or "bungs," each in its own frame and with a rise or spring corresponding to the transverse rise of the roof. The construction of the "bungs" is shown in Fig. 6.

It will be obvious that the construction of the bungs is an important detail, since bad construction might result in the dropping of the bricks of which they are built. There are various designs of bungs, but those shown in Fig. 6 are most usually employed in good furnaces. The width may be either one, one and a-half or two bricks, as found convenient. It will be noted that the essentials in each design are a plate or plates, the edge of which conforms to the contour of the roof, end pieces or shoes which hold the bricks endwise, and a means of tightening or slackening the grip of those shoes on the bricks, this means being either a bolt across the whole arch and nuts at each end, or set screws suitably arranged on each shoe. A centre staple or loop may be provided for lifting the bung in and out of place.

Flue and Stack.—The furnace gases, after passing over the rear bridge, enter the stack through the flue. In constructing this portion of the furnace there should be no sharp corners, but the course of the gases should be rendered as easy as possible by rounding as shown. Not only do sharp corners retard the passage of the gases, but the brickwork becomes badly cut in a very short time. A door is provided in the flue or the bottom of the stack, for cleaning purposes.

Fuel.—An important matter for care in the selection of fuel for an air furnace is to avoid high-sulphur coals. The sulphur contents of coals differ very greatly, and if excessive sulphur is contained in the fuel it will inevitably contaminate the metal in the bath, passing into it through the medium of the fumes of combustion. In some American foundries all coal is refused which analyses over 1.30 sulphur.

(To be continued.)

"F.T.J." Bookshelf.

The Case-Hardening of Steel. By Harry Brearley. (London: Iliffe & Sons, Limited, 20, Tudor Street, E.C.—7s. 6d.).

Despite the great age of the process of cementation of iron, until recent years its different applications have had a purely empirical basis. Metallography, however, has opened up the secrets of this as of other metallurgical problems, and has made it possible to control, determine and regulate the process of cementation in a manner in keeping with the demands of modern engineering. It may be safely said that without the aid of the metallographist case-hardening, which now plays so prominent a part in motor-car and other machine construction, would have remained a "hit-or-miss" process of doubtful reliability, and could not have taken the useful place it has done—at least not to the same extent. Since the successful practical application of case-hardening is so linked up with a knowledge of its theory, it is pleasing to find an author who can present a discussion of the subject in such language and manner as to render it intelligible to any fairly intelligent workman requiring the information. While many of the generally accepted terms of the laboratory must find their way into such a book as this, Mr. Brearley does not use them to the confusion of his readers, but only as indicating what he first defines. In this way the theory and practice of case-hardening are discussed together, and numerous diagrams and micrographs are used to illustrate the processes of carburisation, hardening and tempering. As regards the scope covered by the book, it deals fully with case-hardening and allied operations, describes the practice of to-day, explains its difficulties, discusses its weaknesses, and points out likely roads to improvement. The first chapter discusses the history and meaning of cementation, with reference to the structure of the metal and the condition of the constituents; then the structural changes in the core, and fibre and lamination in the core, are considered. The properties and defects of hardened cases having been discussed, a very practical chapter is devoted to the carburising operation. Some useful information on the suitability of various steels for case-hardening is followed by chapters on carburising reagents and methods of testing, and then the important question of automobile steels is dealt with, this section containing much valuable information in a condensed form. The hardening and tempering processes are graphically described, and a final brief chapter gives some notes on hardening by pressure, flame cutting and blowpipe work. Taken throughout, the book is an excellent and concise treatise suitable for metallurgist and practical man alike.

Messrs. Naish & Croft, consulting metallurgists and analysts, 150, Alma Street, Birmingham, have issued a highly-artistic calendar for 1915, with a reproduction by colour photography of a pastel by Frank Desch.

Trade Talk.

A FIRE broke out recently at the Burnbank Foundry, Falkirk, considerable damage being done.

THE library of the Rugby Engineering Society is now housed at 27, Regent Street, Rugby.

MR. F. LONG, engineers' merchant, 571, Meanwood Road, Leeds, has been adjudicated bankrupt.

MESSRS. DUCROO & BRAUNS, constructional engineers, have removed to 53, Victoria Street, London, S.W.

THE head offices of the Shropshire Iron Company, Limited, of Hadley, near Wellington, Salop, have been destroyed by fire.

MESSRS. DARLING & LLOYD have acquired the business of Mr. R. H. Mason, electrical and general engineer, Lorne Street, Oswestry.

MOSSAY & COMPANY, LIMITED, have removed from 45, Horseferry Road, Westminster, S.W., to Queen Anne's Chambers, Westminster, S.W.

THE London offices of Dorman, Long & Company, Limited, have been removed to Clarence House, 4, Central Buildings, Westminster, S.W.

A BRANCH establishment has been opened in Calcutta by Messrs. B. Dieden & Company, iron, steel, and machinery exporters, of Malmö, Sweden.

H. LEES & SONS, LIMITED, of the Park Bridge Iron works, Ashton-under-Lyne, have been elected members of the Midland Iron and Steel Wages Board.

AT the fifth ordinary meeting of the Huddersfield Engineering Society, a discussion took place on "The Training of Engineering Apprentices."

THE WINDSOR & ASCOT ENGINEERING COMPANY, LIMITED, is being voluntarily wound up, with Mr. W. P. Keeling, 13a, Finsbury Square, E.C., as liquidator.

A FIRE broke out on January 23 in the motor department of the works of Ashmore, Benson, Pease & Company, Limited, Stockton-on-Tees. Considerable damage was done.

THE EASTERN FINANCIAL AND ENGINEERING SYNDICATE, LIMITED, is being wound up voluntarily, with Mr. A. L. Boden, 14, Queen Victoria Street, E.C., as liquidator.

SEVENTY-FOUR of the employés at the Halifax works of the Campbell Gas Engine Company, Limited, have joined His Majesty's Forces, the majority serving in the West Riding Regiment.

THE Foreign Office has announced the adoption by the French Government of lists of absolute and conditional contraband identical with that contained in the Royal Proclamation of December 23 last

THE seventy-sixth annual exhibition of the Royal Agricultural Society of England will be held at Nottingham, from Tuesday, June 29, to Saturday, July 3, 1915. This year the prizes offered total £9,000.

WELLMAN, SEAVER & HEAD, LIMITED, have recently received a repeat order for one of their patented low-ground type revolving charging machines from the Bryngwyn Steel Company, Limited, of Gorseinon.

THE shareholders of Llewellyn & Cubitt, Limited, have passed a resolution to the effect that the company be wound up voluntarily. Mr. E. L. Probert, of Pentre, Rhondda, has been appointed liquidator.

IN the Companies Winding-up Court on January 12 Mr. Justice Astbury made a compulsory winding-up order against the London Steel Castings Company, Limited, on the petition of Lamplough & Son, Limited.

AT a meeting of the members of the Institution of Mechanical Engineers, to be held at the Institution on February 8, the annual lecture will be delivered by Sir Robert A. Hadfield on the "History of the Metallurgy of Iron and Steel."

JOHN WILLIAMS & SONS (CARDIFF), LIMITED, are adding a large bay to the stores at their East Moors Works. When this is completed, the whole of the stock will be held at East Moors, and the company's Queen Street premises will be closed down.

IT is stated that owing to the increased demand for iron and steel created by the war, the Solway Ironworks at Maryport will shortly be re-started. The Solway Ironworks, which were closed about 12 months ago, give employment to about 250 hands.

THE charge which it was stated would be brought against a Glasgow firm for alleged trading with the enemy has been dropped. It appears that the matter originated in pure inadvertence, and that, in fact, there was no foundation for the charge.

THE members of the Manchester local section of the Institution of Electrical Engineers, held their 6th ordinary meeting on January 26 at the Engineers' Club, Albert Square, Manchester, when a paper on "Electrical Steel-making Furnaces" was read by Mr. T. D. Robertson.

A RESOLUTION has been passed by the shareholders of the Viaduct Foundry and Engineering Company, Limited, that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same. Mr. A. D. Greatrex, of Glendale, Llanishen, is the liquidator.

THE partnership heretofore subsisting between Messrs. B. Brabbins, 42, Allen Road, Wolverhampton, and H. Segar, of Hall Park Street, Bilston, carrying on business as engineers, at the Hall Park Engineering Works, Wellington Road, Bilston, under the style of Brabbins Brothers, has been dissolved.

MR. T. A. LAWRENCE has recently added a foundry to his Railway Works, Taffs Well, Glam. Hitherto the whole of the castings, railway chairs and the like have been purchased from outside. In addition to meeting this demand, it is proposed to turn out general castings up to 2 tons in weight.

THE partnership heretofore subsisting between Messrs. C. R. Hough and O. B. Jacobsen, carrying on business as engineers, at 36, Cannon Street, Birmingham, under the style of Hough & Jacobsen, has been dissolved. Mr. C. R. Hough will continue the business under the style of Hough & Jacobsen.

THE average net selling price of Cumberland hematite warrants during the past quarter was 64s. 7d. per ton, which compares with 63s. 11.586d. for the September quarter, 61s. for the June quarter, and 61s. for the first quarter. The average price for the last quarter of 1913 was ascertained as 63s. 3.19d

AT a meeting of the shareholders of Grice's Gas Engine Company, Limited, held at the registered office of the company, Taymouth Engineering Works, Carnoustie, a special resolution was passed to the effect that the company be wound up voluntarily. Mr. R. C. Mathewson, of Carnoustie, has been appointed liquidator.

THE firm of Douglas Primrose & Company, engineers, 163, Hope Street, Glasgow, has been dissolved as at December 31, 1914, by the retirement of Mr. A. M. Mackay, one of the partners. The business will be carried on by Mr. D. Primrose and Mr. G. E. Pipe on their own account under the same firm name, and they will discharge the liabilities.

A CHRISTMAS entertainment was given by Joseph Sankey & Sons, Limited, in the mess room of the Castle Works, at Hadley, to the wives and families of those men who had joined the colours since the beginning of the war. Messrs. Sankey have also sent a parcel to each of the 120 men who have enlisted. The parcels contained sets of woollen articles, cigarettes, chocolates, etc., and were greatly appreciated.

FOR a short time after the death of Mr. William Martin the business of the Dundyvan Iron and Steel Works, Coatbridge, was continued on behalf of his trustees. On January 1, 1914, the whole works and business were acquired by Mr. Martin's sons, Mr. Hugh Martin and Mr. William Martin, and the commercial manager, Mr. A. Neilson. Throughout the year the business was continued under the former name of William Martin, but the company have now resolved to trade under the style of William Martin, Sons & Company.

MEMBERS of the Scotch iron and steel industry have started a fund for the provision of several motor ambulances for use at the front. The cars will bear the picturesque name of "Scotia's Iron Queens." Leading men in the trade have already liberally subscribed, while the Board of Conciliation and Arbitration for the

Steel Trade of Scotland and the Scottish Steel Makers' Association have contributed a sum of £200 each. Mr. C. D. Rigg, of Gartcosh, is the honorary secretary of the fund.

A DEPUTATION of the members of the Welsh Engineers' and Founders' Association, consisting of representatives from Richard Nevill & Company, Limited, the Glanmor Foundry Company, Limited, Thomas & Clement, Limited, Taylor & Sons, Limited, and John Evans & Son, Limited, have had an interview with Mr. Beveridge (manager of the Board of Trade) and Sir George Gibbs (director of contracts at the War Office) on the subject of the distribution of Government work, Welsh firms hitherto not having been invited to tender. The deputation received a sympathetic hearing, and it is expected that a percentage of the work will now be diverted to Wales, where the engineering firms claim they are excellently equipped to expeditiously carry out Government contracts.

THE Council of the Belgian Chamber of Commerce in London (Incorporated) are making an appeal to British manufacturers and merchants for support. Since 1890 the Chamber has rendered valuable services to industries and commerce between the two countries, and its work has now become much more arduous through all the various questions due to the difficulties of trade. After the cessation of hostilities the Council will have important duties to perform in helping the commerce of the two countries, which are now bound up more than ever in ties of mutual trust and friendship; but at present they find great difficulty in carrying out their duties through lack of funds, as the usual subsidies, etc., are not now forthcoming. Contributions to the funds shou'd be sent to the general secretary, Mr. P. Dorchy, 24, St. Dunstan's Buildings, St. Dunstan's Hill, E.C.

IN their review of the past year's trade, Cammell, Laird & Company, Limited, remark that the export of railway material was good up to the end of July, when the outbreak of war seriously affected shipments and caused partial or entire suspension of many important orders, particularly for account of Indian, South American, and Australian markets. The temporary deficiency thus caused was, however, early compensated by the diversion to British works of certain Colonial and other orders placed with Continental manufacturers. The firm secured a very good proportion of these, which were supplemented very considerably by orders secured in markets hitherto exclusively supplied by Germany. At the shipbuilding and engineering works, Birkenhead, the output exceeded in volume that of any previous year in the firm's history, the total gross merchant tonnage launched being 38,000.

AT the meeting of the Sheffield Society of Engineers and Metallurgists, recently, Mr. Arthur Balfour, the retiring president, gave an address, in which he spoke principally of the great part which the Sheffield steel trade is playing in providing war material. Professor J. O. Arnold, the new president, delivered his address on "The Story of Sheffie'd Steel," briefly sketching the history of the trade. In scientific work, he said, Sorby's pioneer micrographic investigations in 1863 stood out in strong relief. He described Sheffield as the greatest naval armoury the world had ever seen, not even excepting Krupp's. At the beginning of the war the heaviest Krupp gun on the North Sea was the 12.2, throwing an 880-lb. shell, while we had many 13.5 guns, throwing 1,400-lb. shells. Touching on the work of Dr. Sorby, Professor Arnold said they had heard much about Germany, and what had been done at Charlottenburg. The facts were that at the present time there were 29 constituents of steel capable of recognition by the microscope; that of these 26 had been discovered in Sheffield, and three in Middlesbrough.

IN consequence of the pressure of Government work the Naval Construction Works, Barrow, of Vickers, Limited, have had to be extended in almost every direction. A large plumbers' shop has been erected on a piece of land in Cavendish Park, bought from the Furness Railway Company, and later on it is proposed to build new engineering workshops on this site. A new shell shop has been built on the shipbuilding side of Messrs. Vickers' yard, and the Company have also deposited plans with the Corporation for the erection of workshops on land adjoining the Walney Bridge and the Devonshire Dock entrance basin. The problem of the future is the housing of the additional workmen required, as there is already a growing scarcity of houses in the town. Messrs. Vickers, we understand, have purchased the Ipswich works of the Consolidated Diesel Engine Manufacturers, Limited, which concern, it will be remembered, went into liquidation. The purchase includes the whole establishment and the site, and Messrs. Vickers will commence operations at Ipswich as soon as the necessary arrangements have been completed.

THE iron trade statistics issued by the Middlesbrough Chamber of Commerce for the last quarter of the year show that at the end of December there were, out of 77 built, 49 blast-furnaces in operation, as compared with 78 built, and 52 in blast at the end of December, 1913. The returns show that during the last quarter of 1914 the production of pig-iron in Middlesbrough was 594,000 tons, 322,000 tons being Cleveland iron and 272,000 tons hematite, spiegel, basic and other special irons. For the previous quarter the output was 572,000 tons, 300,000 tons being Cleveland pig, and 272,000 tons hematite, etc., and for the last three months of 1913 the make was 610,000 tons, 350,000 tons being Cleveland iron, and 260,000 tons hematite, etc. The production during the year 1914 was 2,391,000 tons, 1,307,000 tons being Cleveland, and 1,084,000 tons hematite, etc., as compared with 2,701,000 tons in 1913, of which 1,586,000 tons was Cleveland and 1,135,000 tons hematite, etc. The production in 1913 was the highest on record, and last year's was the second best. Imports of foreign ore to Middlesbrough last quarter reached 325,629 tons, as compared with 484,871 tons during the previous quarter, and 552,392 tons during the fourth quarter of 1913. The total import for the year was 1,819,813 tons, against 2,297,586 tons in the previous twelve months.

IN consequence of an explosion of molten metal at the Consett Iron Company's works on January 15, one man was killed and three others seriously injured. The men were engaged in pouring the metal into a mould. The inquest was held on January 18, when the foreman said he was superintending the tapping of a steel-melting furnace while the deceased was engaged in pouring the molten steel into the mould. When the work had been in progress for a short time, witness went away, when he heard an explosion. He returned and, after attending to the injured, he had the mould lifted from the plates. The mould was 2 tons 7 cwts. in weight, 5 ft. 6 in. long, and the ingot itself would weigh about 32 cwts. He examined the ingot after the mould had been removed, and found a flaw in it, about 19 in. from the bottom. There was no flaw in the mould. Mr. J. R. Williams, manager of the steel works, said the explosion was evidently due to the temperature of the steel being so intense when passed into the mould that when it came into contact with something an explosion was caused. J. Fagan, engineman, stated that it seemed that something had been left in the mould, and that it had not been observed by the examiner. The jury came to the conclusion that it was more forgetfulness and carelessness than anything else that had caused the explosion, and returned a verdict that deceased died from shock.

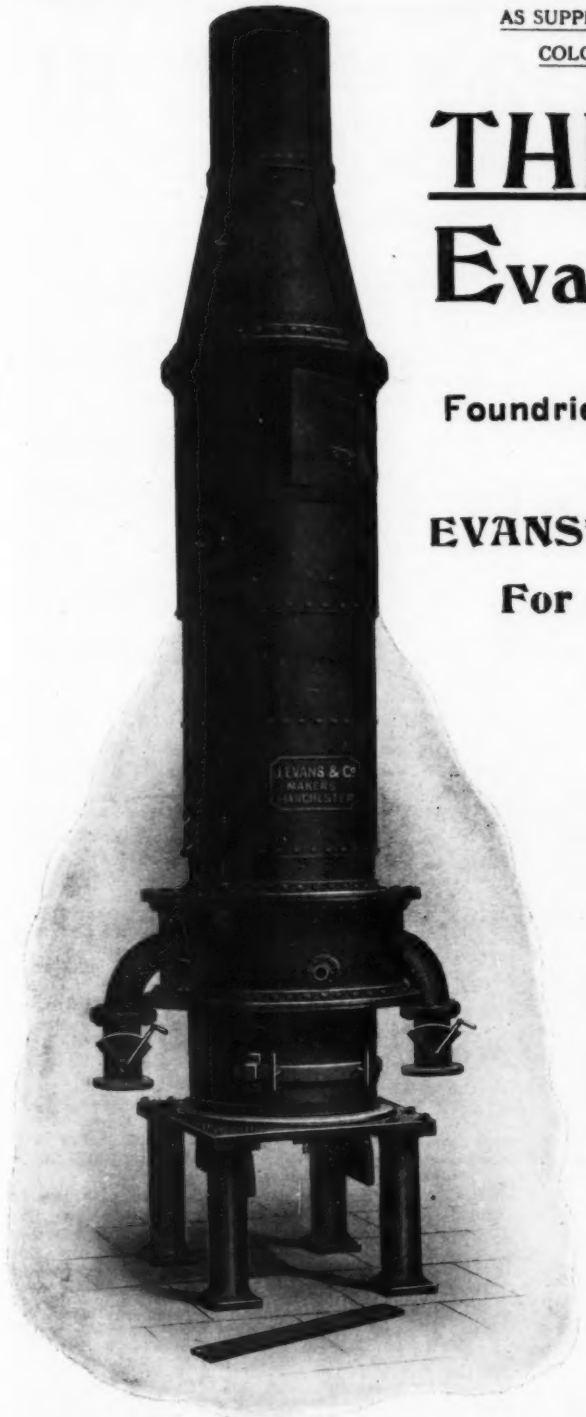
PALMERS SHIPBUILDING & IRON COMPANY, LIMITED, having, with the consent of their debenture holders, made satisfactory arrangements with their bankers for the loan of the necessary money, have put in hand extensive improvements and additions to their plant, which the company has for some time been desirous of carrying out. The extensions concern primarily the iron and steel works of the company at Jarrow, and they have been devised with the object of effecting large savings in the cost of steel production, and will generally bring the works up to a high state of efficiency. The necessity of improving the plant at the steel works had been felt for some time, and in this connection particularly that used in the generation of the energy required to work the machinery in the steel works, shipyard and engine works. The improvements already undertaken

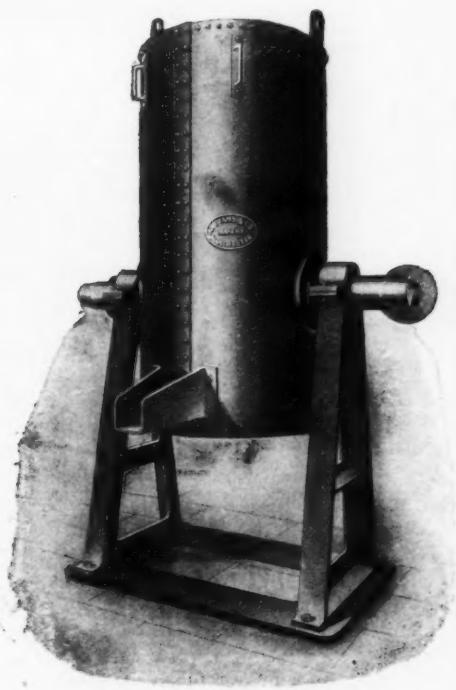
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

include a large gas-driven power house, in which will be installed approximately 15,000 b.-h.-p. of gas engines, all driven by the waste gases from the blast furnaces; a new lay-out of the heavy cogging mill, which it is intended to drive electrically, together with the conversion of all the steel works auxiliaries from steam to electricity, by which large savings in the cost of coal will be effected; a new gas-producing plant for the steel melting furnaces, together with modern soaking pits for same. It may be noted that the installation of gas engines and gas-cleaning plant that has been placed by the company is understood to be the largest hitherto ordered in this country. There is every reason to believe that some of the plant will be in operation after the midsummer of this year.

An early boom in the iron and steel industries is not anticipated by Mr. F. Mills, managing director of the Ebbw Vale Steel, Iron and Coal Company, Limited, but he considers the industry has a bright future before it, particularly in South Wales. In the course of an interview granted to a representative of the Press, Mr. Mills remarked that manufacturers would not be justified in working for stock and warehousing it, to sell when peace was declared. The amount of capital involved would be enormous, and no banks would undertake such a risk. They had practically no unemployment. Out of the 12,000 men at Ebbw Vale over 4,000 had joined the colours. Messrs. Lysaght's, too, seemed to have done well in this respect, for between 800 and 900 of their Newport men had gone. There was no unemployment, so there would be no need to finance production. "Then, again" (continued Mr. Mills), "when the war ends the demand for the special goods now being manufactured will cease, and we shall have to adapt ourselves. The trade will have to come back into normal conditions of manufacture. No, I do not anticipate an early boom, although, as I have said, I have every confidence in future prosperity. America will get cheap rates, probably through the liners carrying the goods as ballast, just as the provisions come. But you may depend upon it the American manufacturers will take almost any price in order to get a look in. The assumption that Belgian and German works, which have been our chief competitors, will not be able to supply us after the war, is no doubt correct. But it does not follow that the whole of the trade they formerly did will come to the British manufacturer at once. Our trade will, no doubt, rest upon a firmer basis. The stuff sent here has been dumped below cost, as I have ascertained by special inquiries made by experts all over the Continent. But our works here will require a price that will yield a profit, and will have to operate in stiff competition against America."

Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

24,356.*Foundry moulding machines. J. E. H. Craven.
24,517. Testing machines. W. & T. Avery, Limited, and H. W. Goulding.
24,646.*Method of autogenous welding or fusing of nickel and alloys containing a high percentage of nickel. R. Sameasreuther and Autogenwerk Sirius G.m.b.H.
24,789.*Roots' blowers. C. J. Rixen.
24,681. Regenerative furnaces. Drakes, Limited, and W. A. Drake.

1915.

74. Separation of metals or alloys consisting of mechanically-mixed particles. V. G. Stevens.
782.*Processes and furnaces for generating heat. W. Thomas and A. E. Mainwaring.
1,010. Metal-melting furnaces. I. Hall.

Deaths.

Mr. David Henderson, of the firm of A. Henderson & Sons, engineers, Easter Road, Edinburgh, died on January 24.

The death has taken place at his residence in Aberdeen, of Mr. P. M. Barnett, engineer-in-chief to the Great North of Scotland Railway Company.

The death is reported from the United States of Mr. C. S. Price, formerly president of the Cambria Steel Company, of Johnstown, Pa.

Sir Frederick Howard, who founded the firm of J. & F. Howard, ironfounders, Bedford, died at his residence at Bedford on January 6. The deceased, who was 87 years of age, was created a Knight in 1895.

Mr. C. M. Hall, vice-president of the Aluminium Company of America, died recently after a protracted illness. After completing his education the deceased turned his attention to the problem of producing pure aluminium by a cheaper process than then in vogue, and subsequently became one of America's greatest chemists.

The death took place at Leeds on January 4 of Mr. A. S. S. Keith, works manager to Walter Scott, Limited, of the Leeds Steel Works. He had been ill for a long time. Mr. Keith, who was in his sixtieth year, became manager five years ago, after previously serving as blast-furnace manager and assistant works manager. He went to Leeds from Middlesbrough.

The death took place on January 23 of Mr. Thomas Gill, aged 82 years, one of the early pioneers of the iron industry at Middlesbrough. Mr. Gill was originally a member of the firm of Jackson, Gill & Company, Southbank Ironworks, Middlesbrough, and for the last 30 years had represented his brother's firm of Gill & Russell, Limited, tube makers, Walsall.

The death is announced of Mr. R. L. Kirby, of Middlesbrough, at the age of 78 years. In 1866 the deceased entered the employment of Bell Bros., Limited, with which firm he remained in association till his death. He was appointed secretary of the company on its formation into a limited liability concern, and his long services were recognised by his election to the board of directors in 1912.

Mr. A. W. Cooper, engineer, of Dundee, died on January 4 after a short illness, at the age of 62 years. The deceased gentleman was a native of Dundee, and he served his apprenticeship as an engineer in the city. Shortly afterwards he entered into partnership with Messrs. J. & H. Whyte, and established the Britannia Engine Works. On the retirement of Messrs. Whyte, Mr. Cooper assumed as his partner Mr. J. S. Greig, the firm being known as Cooper & Greig.

The death is announced of Mr. J. C. Ridley, who during his business career had been associated with Robert Stephenson & Company, Limited, the Wallsend Blast Furnaces and Coke Ovens, and the Jarrow Rolling Mills. Some years ago he established the business of Bell, Ridley & Bell, Walker Iron Works, Newcastle, but this was subsequently closed down. In later life he established the Swalwell Steel Works, under the style of Ridley & Company, but these works were also stopped after a successful run of many years.

Sir Owen Roberts, one of the earliest advocates of technical education in London, has died at his residence, Henley Park, Guildford. The deceased gentleman was born in Carnarvonshire in 1835, and was knighted in 1888 in recognition of the public services he had rendered in the cause of technical education. It was in a great measure due to him that the dye industries of Yorkshire and the West of England received so much encouragement at the outset. He was likewise concerned in the institution of the City and Guilds of London Institute, and for eleven years served on the Technica' Education Board of the London County Council, being chairman of the Polytechnics Committee from 1891 to 1902. He was also a vice-president of the Royal Society of Arts, and a member of the governing body of the Imperial College of Science and Technology at South Kensington.

IN THE FRONT RANK

IS WHERE YOU DESIRE YOUR PRODUCTS TO BE.

This can only be now maintained by efficient and labour saving equipment.

AUTOMATIC PREPARING PLANTS FOR FOUNDRY SAND.

Plants from one to twenty tons per hour have returned greater interest on money invested than many a more pretentious invention.

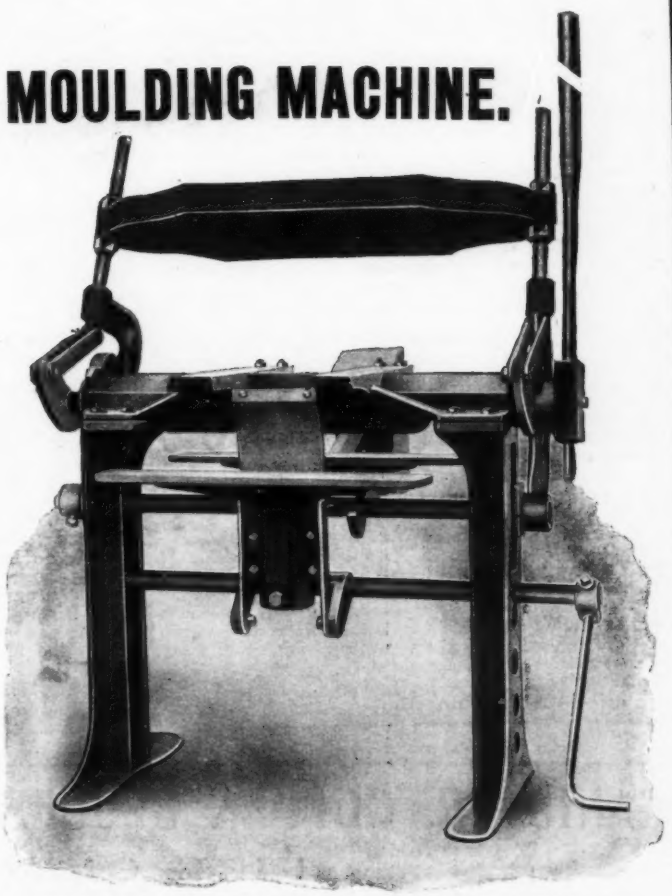
SAND MIXING, TEMPERING AND SCREENING MACHINES.

SAND ELEVATORS AND CONVEYORS.

CORE MAKING MACHINES.

CUPOLA CHARGING MACHINES.

MOULDING MACHINE.



For Moulding Light Work in Boxes up to 22in. by 18in., by ordinary moulding, match plate work and stripping plate work.

THE MIDLAND IRONWORKS (NEWARK), LTD.,

NEWARK-ON-TRENT, NOTTINGHAMSHIRE.

Personal.

THE late Mr. J. Gimson, retired engineer, a director of Gimson & Company (Leicester), Limited, left £52,947 gross, including £18,936 net personalty.

MR. J. F. DAVIES, general manager of the Gas Stove Department of John Wright and Eagle Range, Limited, has been elected a director of the company.

MR. G. J. WELLS has been awarded the Denny gold medal of the Institute of Marine Engineers for his paper on "Thermodynamics and Refrigeration."

THE late Mr. D. M. McKechnie, of Messrs. McKechnie Brothers, copper smelters and metal merchants, of Widnes, left estate valued at £73,480 gross.

MR. C. F. BENGOUGH, of York, has been appointed to the position of chief engineer of the North-Eastern Railway Company, in succession to Mr. C. A. Harrison, retired.

To mark the conferring of the honour of knighthood upon their employer, Sir John Cowan, the employés of the firm of Redpath, Brown & Company, Limited, Edinburgh, presented him with an address on January 18.

MR. E. G. CONSTANTINE, who has been associated with the Stirling Boiler Company, Limited, for many years, has retired from active business, and resigned his position as managing director, remaining, however, a director of the company. He is succeeded in the management by Mr. H. J. S. Mackay.

MR. C. J. FAIRFAX SCOTT having resigned the secretaryship of the British Iron Trade Association, has now taken up his duties as secretary of the Institute of Industry and Commerce (Exhibition Buildings, Aldwych Site, Strand, W.C.), to which post he was recently elected by the court of directors.

MR. J. MOIR and Mr. A. Welch, works directors, have ceased to be connected with the Clyde Shipbuilding and Engineering Company, Limited, Castle Works, Port Glasgow, and in their place the directors have elected Mr. R. G. Turnbull, late of Sir Raylton Dixon & Company, Middlesbrough, as manager and director.

MR. R. S. BRAILSFORD, MR. W. W. SPOONER, and MR. A. BRAILSFORD have been elected directors of Cole, Marchent & Morley, Limited, these gentlemen having purchased the entire share holdings of Mr. H. W. Morley, Mr. G. Hodgson, and Mr. D. H. Illingworth, who have now retired from the directorate and management of the company.

MR. A. C. COOK, of the Warner & Swasey Company, Cleveland, U.S.A., Mr. L. M. Waite, vice-president of the Fitchburg Machine Works, Fitchburg, Mass, and Mr. H. A. Hammond, of the Rome Wire Company's export department, New York, are at present in this country, while Mr. W. G. Fuller, of Alfred Herbert, Limited, of Coventry, is in America negotiating with machine tool makers with regard to the sale of their products in Great Britain.

New Companies.

"B. C." Brassfoundry Company, Limited.—Capital £2,000 in £1 shares. Registered office: 54½, Staniforth Street, Birmingham.

United Machinery and Engineering Stores Company, Limited.—Capital £5,000 in £1 shares (100 founders, and 4,900 ordinary and six per cent. preference).

Phonolux, Limited.—Capital £2,500 in £1 shares, to carry on the business of general and mechanical engineers. Registered office: 62-3, Queen Victoria Street, London, E.C.

Donkin & Company, Limited.—Capital £66,000 in £1 shares, to carry on the business of engineers, etc. Registered office: St. Andrews Works, Walkergate, Newcastle-on-Tyne.

Hydrolio Furnace Company, Limited.—Capital £2,000 in 1,975 preferred ordinary shares of £1 and 500 deferred of 1s. Registered office: 31, Ivy Street, Hoxton, London, N.

P. Williams & Sons (Furnaces), Limited.—Capital £30,000 in £1 shares, to carry on the business of ironmasters. Registered office:—P. Williams & Sons' Offices, Wednesbury Oak, Staffs.

Pullan Engineering Company, Limited.—Capital £3,000 in £1 shares, to take over the business carried on by C. Pullan at 80, King's Arcade, Bradford. The first directors are C. Pullan, C. H. Best, V. Learoyd and W. Myers.

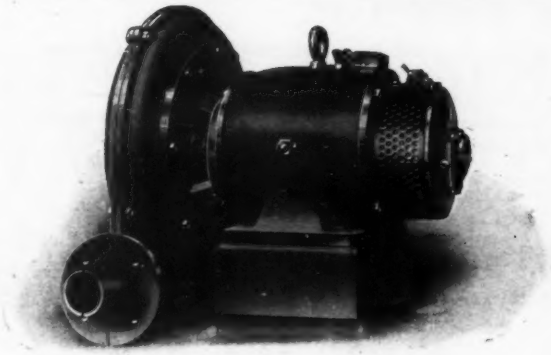
Wm. Pender & Company, Limited.—Capital £3,000 in £1 shares, to take over the business of manufacturers of iron and steel carried on at the Diamond Steel Works, Grahamstown, Falkirk, by William Pender & Company.

Vivian & Sons, Limited.—Capital £650,000 in £1 shares (450,000 "A" and 200,000 "B"), to adopt an agreement with Sir Arthur P. Vivian, the Hon. Odo R. Vivian, Captain A. W. Heneage, C. H. Eden, Lady Swansea, and the Right Hon. Lord Swansea, and to carry on the business of smelters of copper ore, etc.

Mellor, Bromley & Company, Limited.—Capital £10,000 in £1 shares (5,000 preference), to take over the business of engineers and machine builders and iron and brassfounders, carried on by Moses Mellor & Sons, Limited, at Leicester, and to enter into an agreement between the old company and T. C. Bromley. The first directors are J. G. Raphael (chairman) and T. C. Bromley.

Maud & Turner, Limited.—Capital £12,000 in £1 shares, to take over the business carried on at the Perseverance Works, Gibbet Street, Halifax, and to adopt an agreement between H. Maude and E. Boot of the one part and J. Evison of the other part, and to carry on the business of tool makers, founders, etc. The first directors are G. Stirk, E. Stirk, R. Stirk and J. G. Stirk. Registered office:—Perseverance Works, Gibbet Street, Halifax.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."



10 H.P. Fan and Motor.

TRADE SIROCCO MARK

High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

Davidson & Co., Ltd.,

Sirocco Works,
BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph: ELDER, CARDIFF. Telephone: 4640 and 4641.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-Iron.

	Feb. 4. s. d.
Cleveland.	
Cleveland No. 1	58 6
„ No. 3	56 6
„ No. 4 foundry	56 0
„ No. 4 forge	55 6
„ Mottled	55 0
„ White	55 0
East Coast hematite, mixed Nos.	95 0
Cleveland warrants	56 5

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	56 3
Warrants, ditto	62 7½

Makers' prices:—	s. d.		s. d.
Gartsherrie No. 1	76 0	No. 3	71 0
Coltness No. 1	92 6	No 3	72 6
Summerlee No. 1	77 6	No. 3	72 6
Langloan No. 1	77 0	No. 3	72 0
Calder No. 1	75 0	No. 3	68 0
Clyde No. 1	76 6	No. 3	71 6
Carnbroe No. 1	74 0	No. 3	70 0
Monkland No. 1	71 6	No. 3	70 0
Shotts No. 1	77 0	No. 3	72 0

(All deliverable alongside Glasgow.)

Glengarnock	No. 1 76 0	No. 3	71 0

(Deliverable alongside Ardrossan.)

Dalmellington	No. 1 71 6	No. 3	69 6
Eglinton	No. 1 70 0	No. 3	69 0

(Deliverable alongside Ayr.)

Carron	No. 1 77 6	No. 3	72 6

(F.a.s. Grangemouth.)

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	—
Lincolnshire No. 3 foundry	65 9	66 0
Derbyshire No. 3 foundry	63 0	64 0
Staffordshire No. 3 foundry	63 0	64 0
Cleveland No. 3 foundry	—	—

(All delivered equal Manchester.)

Scotch No. 3	Gartsherrie	—	—
	Glengarnock	—	76 0
	Eglinton	—	—
	Summerlee	—	76 0

(Delivered Manchester Docks.)

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	—	95 0
Hematite warrant net cash	—	84 0
Lorn cold-blast charcoal iron	180 0	190 0

The Midlands.

		s. d.	s. d.
Staffs.	Common forge	55 0	56 0
	Part Mine forge	60 0	61 0
	Best All Mine	82 6	85 0
	Cold Blast	—	130 0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry	—	—
Leicestershire foundry	—	—
Shropshire Cold-Blast	—	132 6

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s. d.	s. d.
Forge	—	—
Grey forge	—	—
Basic	—	—
No. 3 foundry	—	—
No. 4 foundry	—	—

F.o.t. Makers' works.

South Wales.

	s. d.	s. d.
Welsh Hematite	92 6	95 0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	28 0 0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	26 0 0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	24 10 0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	60 0 0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy	0 9 0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit Per ton	15 0 0
Ferro-titanium: 15/18%, per pound, flat	0 0 6½
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0 18 0
Ferro-phosphorus: 20/25%. Per ton	16 10 0
*Ferro-manganese 80%	12 0 0
„ export	—

* F.o.b. Liverpool.

Iron Castings

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6 to	7 12 6
Pipes, 1¼ to 2½ in.	6 10 0	6 15 0
„ 3 to 4 in.	5 17 6	6 0 0
„ 5 to 8 in.	5 12 6	5 15 0
„ 10 to 16 in.	5 15 0	—
„ 18 to 24 in.	5 15 0	—
Chairs	4 7 6	4 10 0
Floor plates (open sand) (At work	3 10 0	3 12 6

Non-Ferrous Metals.

	£ s. d.	£ s. d.
Copper.		
Standard, Cash	62 2 6	62 7 6
Three months	62 12 6	62 17 6
Electrolytic	67 15 0	63 5 0
Tough	—	65 10 0
Best selected	—	65 10 0
Tin.		
Standard, Cash	170 10 0	171 0 0
„ Three months	152 10 0	153 0 0
English Ingots	—	172 10 0
Bars	—	173 10 0
Refined	—	—
Spelter.		
American	—	38 5 0
Specials	—	—
Hard	—	31 0 0
British	—	39 0 0
Lead.		
Soft foreign	—	18 12
English	—	19 5 0
Antimony.		
Regulus	—	72 0
Aluminium.		
Virgin Metal, 98/99% per ton	86 0 0	
***Chromium (Metallic).**		
98/99% purity per lb.	—	
***Nickel.**		
In cubes, 98/99% purity Per ton	205 0 0	
***Tungsten Metal Powder.**		
96/98% purity per lb.	0 5 0	
***Molybdenum Metal.**		
96/98% purity per lb.	—	
***Cobalt Metal.**		
97% purity per lb.	0 8 0	
Quicksilver.		
75 lb. bottle	11 10 0	

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d. to s. d.
Steel scrap, heavy melting	60 0 to 62 6
Iron scrap cast (cupola metal)	55 0 57 0

London (f.o.b.).

	s. d.
Heavy steel	55 0
Light „	40 0
Heavy cast	52 6

Non-Ferrous Scrap.

London merchants quote, delivery free, and subject to market fluctuations:—

	J. B. Garnham and Sons. £ s. d	A. Joseph. £ s. d.
Brass	43 10 0	44 10 0
Clean copper	59 0 0	56 0 0
Braziery copper	54 0 0	50 0 0
Old lead	16 15 0	17 10 0
Tea lead	—	16 0 0
Old zinc	22 0 0	29 0 0
Hollow pewter	130 0 0	115 0 0
Black pewter (shaped)	80 0 0	85 0 0
Gun metal	53 0 0	55 0 0
Aluminium (cuttings)	—	65 0 0

Stocks.

Pig-Iron in Public Store.

	Feb. 3. Tons.	Inc. + or Dec. − since Feb. 4. 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes	—	−12
Connal's at Middlesbrough	118,405	− 16,279
Connal's at Middlesbrough hematite	—	No change.
West Coast hematite	3,962	− 4,452

Metals.

Copper, Europe and afloat	35,125	+ 9,181
Tin, London, Holland, U.S.A. and afloat	16,681	− 670

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	12 6	—
Foundry Coke	19 6 to	21 0
Furnace coke	—	17 9

Newcastle-on-Tyne.

	F.o.b. Dunston. s. d.
FOUNDRY COKE—	
Original Garesfield	19 9
Mickley	20 0
Stella Garesfield	20 0
Priestman's Garesfield	20 0
Consett Garesfield	19 9
Newcastle gas coke	13 0

Cardiff.

	s. d.	s. d.
Special foundry coke	30 0 to	33 0
Foundry coke	24 0 to	28 0
Furnace coke	20 0 to	22 0

Leeds.

Furnace coke (washed)	13 6 to 14 6

Birmingham.

Foundry coke	—	—
Furnace „	—	—
Gas „	—	—

Glasgow.

Foundry coke	—	—
Furnace „	—	—
Gas „	—	—

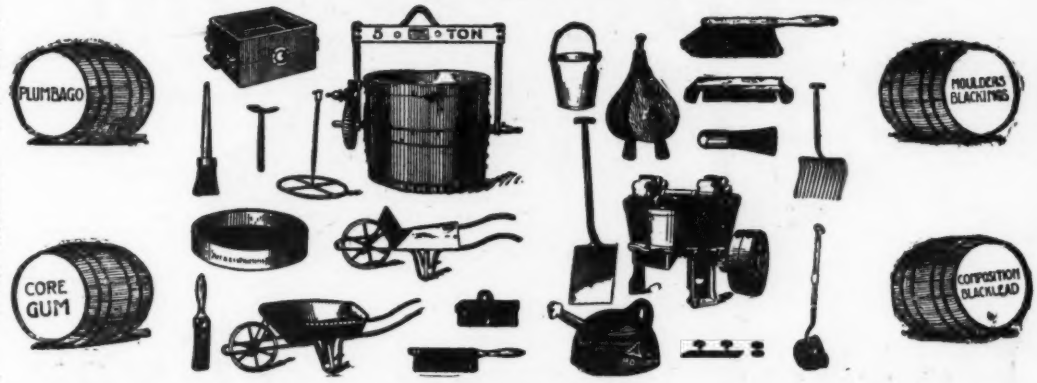
London.

Foundry coke	—	—
Gas coke (Beckton), into barge	—	—
„ into wagon at Works	—	—
Gas coke, Provincial (London sidings)	—	—

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



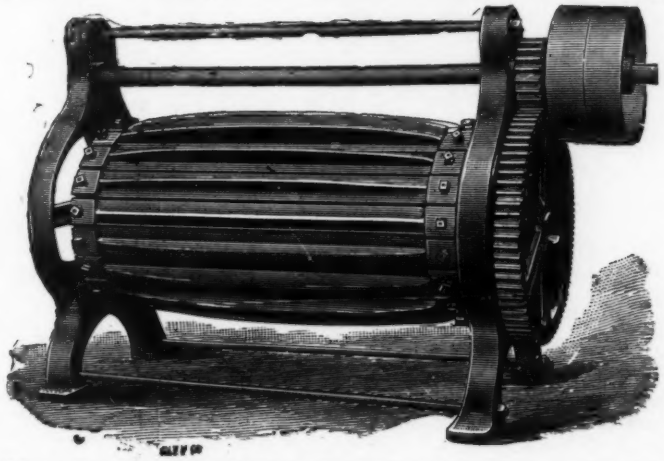
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Patent Sand Mixer

Uses up more old sand than has hitherto been considered possible.

Our Patent Sand Mixer has the following desirable advantages.

The sand is thoroughly aerated, rendered light and loose in texture and of even temper.

Previous milling of the sand is unnecessary.

Seven hundredweights of sand dealt with per minute.

All bearings are ball bearings.

All gears are casehardened steel.

All gears and bearings run in an oil-bath rendering them practically everlasting.

Cages easily examined and cleaned.

Cages do not clog as there are no curved passages.

Machines can be seen in operation in our foundries, Edgwick, Coventry.

ALFRED HERBERT, Limited,

Coventry.

IMPORTANT TO IRONFOUNDERS.

MOULDING—
—MACHINES

FOR REPETITION FOUNDRY WORK.

Illustration of

HAND PRESS MACHINE

for Small Repetition Work, giving rapid and Economical Production.

Makers also of a

HAND RAMMING MACHINE

where a Deep Lift is required. Can be Op:rated by

UNSKILLED LABOUR.

MOST EFFICIENT AND ECONOMICAL IN USE.

Also Makers - - of - - ROOTS' "ACME" BLOWERS.

FULL PARTICULARS FROM—

Samuelson & Co., Ltd., Banbury,

ENGLAND.

SEE OUR ADVERTISEMENT EVERY ALTERNATE MONTH.

"FOUNDRITE."

"FOUNDRYMEN have been seeking this material for years."

Supplied only in 40 gallon Casks. No bulk broken.

FOUNDRITE is another German speciality superseded and improved.

FOUNDRITE is **the** binding material for moulding sand and cores.

FOUNDRITE SUPERSEDES and makes unnecessary all classes of **CORE GUM, LINSEED OIL and all other BINDING material.**

FOUNDRITE will renew old and burned sand, making it usable over and over again.

FOUNDRITE makes **CORES** unbreakable and the use of **core irons** unnecessary.

FOUNDRITE leaves **CORES** perfectly porous and does **not shrink.**

FOUNDRITE has been **"found right"** for all **Sand binding** in the Foundry **for all purposes.**

FOUNDRITE is supplied in **LIQUID** form ready for use. Dilute with Water.

The porosity of the core is perfect, and cores so made do not shrink.

No blowing, cracking, crumbling, honeycombing, or loss of strength can take place.

COST OF USING "FOUNDRITE."

For ordinary work the price is about One Penny per gallon.

FOUNDRITE is used in all important Foundries in Great Britain and the Continent.

FOUNDRITE SAVES MONEY.

FOUNDRITE PREVENTS WASTERS.

Telegraphic Address—"MOROD, SHEFFIELD." **Telephone 4318.**

F. C. MOORWOOD & Co., 7, East Parade, SHEFFIELD.

FOUNDRY EXPERTS.

SITUATIONS VACANT AND WANTED.

STEADY MOULDER, married, 35, seeks situation. No dismissal after war. Excellent experience, cupolas, etc. Must be permanent. Charge of small Foundry accepted. Reasonable wages taken.—Box 457, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

COREMAKER'S Charge Hand desires change. Loam and Sand. Well up. Good refs. as such. Age 36.—Address COLE, 40, Glengall Road, Cubitt Town, London.

ENERGETIC Iron Foundry FOREMAN (32) accustomed to High-class heavy Engineering Castings in Dry and Green Sand, desires change. Good organiser, Abstainer, I.C.S. Student.—Apply, Box 546, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

HALL'S INVINCIBLE SAND MIXERS will utilize your Old Sands and prepare New Sands at the lowest cost per ton. Grinds, Screens, Mixes, and Toughens at one operation. To be seen at work.—Apply C. E. V. HALL, Paradise Chambers, Sheffield.

TO BRASS FOUNDERS AND OTHERS.—For SALE, almost new HAND MOULDING MACHINE, SAND MILL, ROTARY SIEVE, First Class GAS ENGINE, LATHES, and other Machines.—Apply Box 490, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED—(*Continued.*)

A No. 30 BAKER BLOWER or EXHAUSTER, practically new, with machine-cut steel wheels, outside bearings and pulleys. Price £80, free on rails.—Apply JOHN VARLEY & CO., LTD., Waterloo Foundry, St. Helens

1000 Yards of File and Coremaker's CARDING 5 in. wide, 4 ft. long, at 4s. 6d. per dozen yards.—FOXALL, Moulders, Nail, and Chaplet Maker, Wollescote, near Stourbridge.

COMBINED MORTAR MILL, ENGINE and BOILER 7 ft. pan; ditto, with 6 ft. pan.
JOSEPH PUGSLEY, Cattybrook Ironworks, Lawrence Hill, Bristol.

NAISH & CROFT,
Consulting Metallurgists and Analytical Chemists.
— SPECIALISTS IN FOUNDRY WORK. —
Laboratory for all kinds of Metallurgical Investigations.
ANALYSES. MICROGRAPHS. MECHANICAL TESTS.
When you have trouble write us. Fees on application.
Special Terms for Contract Work.
Address: **150, ALMA STREET, BIRMINGHAM.**
London Office: 9 & 10, Fenchurch Street.

FRODAIR
SPECIAL PIG IRON
for
CYLINDERS, CHILLED CASTINGS, MACHINE CASTINGS, and any :: :: FOUNDRY PURPOSE. :: ::

ASK FOR OUR SUGGESTIONS FOR ECONOMICAL IRON MIXTURES.

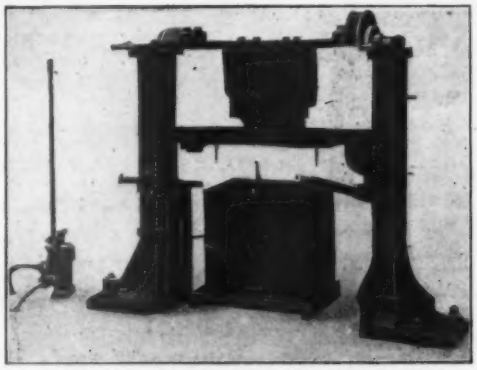
THE FRODAIR IRON & STEEL CO., LTD.,
Fenchurch House, LONDON, E.C.

THE "CHIPCHASE" PATENT

MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

SIMPLE - STRONG - DURABLE



This illustration shows the 3rd position in the making of axle boxes.

THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

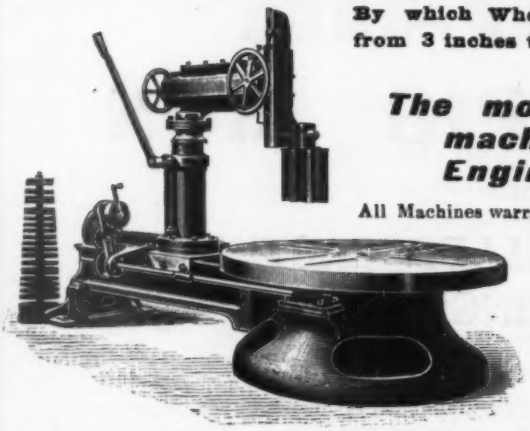
DAVID BRIDGE & Co., Ltd.,

CASTLETON FOUNDRY, CASTLETON, MANCHESTER.

38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
38"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE



By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***